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VOLUME I – TECHNICAL APPROACH

INTRODUCTION

Our proposal responds to a request for contractors qualified to assist in ensuring that traffic data collected for the LTPP program at SPS-1, -2, -5, -6 and -8 locations is of known reliability and preferably of research quality as defined by the *Data Collection Guide for SPS WIM Sites*. This objective will be completed by a combination of data reviews, on-site evaluations and calibrations as directed by the FHWA.

Scope

This project currently covers 79 locations including 15 SPS-1 sites, 14 SPS-2 sites, 17 SPS-5 sites, 13 SPS-6 sites and 20 SPS-8 sites. Although not all sites currently have working equipment, it is expected that information will be developed for all sites during the life of this project with respect to the quality of data produced and the sufficiency of the available data to meet LTPP objectives. Sites that have evolved into the GPS rehabilitation experiments are included as are sites in the SPS-8 experiment where minimal loading is expected. Additionally, sites may be monitored throughout the life of this contract to determine the reliability of the data over time and possible causes for failure to produce research quality information.

Objective

The project is focused on determining the quality of the traffic data being provided to the LTPP program at SPS-1, -2, -5, -6 and -8 locations. The elements of quality begin with the equipment and its installation and go through validation of field performance, calibration of equipment as needed, and analysis of data leading to a report on whether the data is of research quality and if not, what steps might be taken to reach that threshold. A breakdown of the elements in the quality process include:

- Determining the existence and condition of on-site equipment including software, maintenance needs and operational capabilities.
- Determining whether research data quality can be obtained as a function of existing pavement conditions.
- Determining from field validations the reliability of current data at working sites for weight data.
- Verification that the classification information provided does in fact represent the observed traffic stream with an acceptable level of classification errors.
- Verification that sites with minimum loading requirements are in fact experiencing minimum loading conditions.
- Determining if research quality data may have been obtained in past years assuming correctly functioning equipment to meet minimum continuous data needs.
- Performing QA on newly installed systems to verify that research quality data can be collected.

In this process where more than one WIM system is installed at a site, both systems will be addressed with the same standards and attention to detail as the primary LTPP system.

The determination of data quality is based on two sets of criteria. The first applies to loading data and is shown below where confidence limits are based on two standard deviations computed using the Normal distribution or Student's t-distribution depending on sample size.

SPS-1, -2, -5, -6 and -8 Sites	95 Percent Confidence Limit of Error
Loaded single axles	±20 percent
Loaded tandem axles	±15 percent
Gross vehicle weights	±10 percent
Vehicle speed	±1 mph [2 km/hr]
Axle spacing length	± 0.5 ft [150 mm]

The second applies to classification data and relates to conditions on both the total vehicle population and the truck population by itself. The conditions are:

- No more than 2 percent of the vehicles recorded are reported as "unclassified" and
- The number of classification errors involving truck classifications is less than 2 percent.

How is the work accomplished?

This project is broken into three major tasks: assessment, WIM performance evaluation and calibration, and VC performance evaluation. All tasks are ordered for sites at which equipment is installed and capable of collecting data. The sites can be existing installations or those recently installed or upgraded for the collection of traffic loading data at LTPP SPS sites.

Task 1, WIM and VC System Field Assessment, involves three basic activities: gathering all available traffic, equipment, pavement and contact information to prepare for a site visit; visiting a site with agency cooperation to verify the available information, running preliminary checks of the equipment, obtaining any missing site related information, and an analysis activity that concludes with a site report discussing the equipment, the information needed to conduct a performance evaluation and a conclusion on the likely outcome of a performance evaluation. The intent of an assessment is to identify all possible existing conditions that may contribute to failure of an evaluation without actually using test trucks.

Task 2, WIM and VC System Field Performance Evaluation and Calibration, involves three basic activities, pre-visit coordination, on-site system evaluation (the majority of the effort) and reporting on data reliability for the system. The pre-visit coordination involves contacting the agency and any other contractors involved to schedule the work and identify any changes since the most recent assessment or evaluation. The on-site work for existing systems consists of:

- Measuring the test trucks for static weights and their actual axle spacings,
- Running those trucks across the scales to obtain weights, speeds and spacings for evaluation conjunction with the static measures with respect to the research data criteria,
- Performing an evaluation on the spot to determine if calibration is needed,
- Doing any required calibration activities, and,
- Validating the calibrations to obtain an end of visit data reliability.

For systems installed by the Phase II contractor, calibration is not the responsibility of the Phase I contractor but all other activities are. The work done on site including all the analyses is reported to FHWA along with the success or failure of the site with respect to research quality data criteria and recommendations on how best to achieve research quality information where it does not exist.

Task 3, VC System Field Performance Evaluation, focuses on sites lacking working weigh-in-motion equipment but having vehicle classification systems installed and working. In addition to the pre-visit coordination activities following an assessment, this task involves spending at least eight hours on site to obtain a pictorial record of vehicles and the classification assigned to them by the equipment. Analysis done on-site is used to determine if calibration of the system is required or if it meets the research quality standards. If the site can be calibrated it will be, if not, recommendations will be made on actions that might be taken to improve data quality. This task is also summarized by a report including a visual record, the analysis and an assessment of the data quality.

What are the deliverables?

The deliverables on this project consist of schedules, reports for each site assessment, site evaluation or site calibration requested, and quarterly reports.

As the primary mechanism for tracking progress on task orders that have been issued, a master schedule of field activities is required by the contract. This item will be initiated with the first task order on the contract. It will be updated at least monthly and on receipt of new task orders. Each of the tasks identified in the contract involves data collection, analysis and reporting on the task results for each site. While the information varies depending on the task requirements, a standard format for each task will be developed and provided to FHWA for review. The proposed organization of the master schedule is by task order, and within task order by agency. For any given agency not all sites may have the same required task, so within an agency, the schedule will be organized by site. It is expected that for operational efficiencies all on-site activities in a state or province in the same Task Order (TO) will be done as a group.

The task report formats proposed in the task discussions will be revised in consultation with FHWA so that the same information may be located in a consistent place over time. Reports will be provided within 15 days of the completion of field and data analysis activities. They will be provided no later than 90 days after issuance of a task order for a site assessment or VC evaluation and no later than 120 days after issuance of a task order for a WIM site evaluation or calibration.

As required by the RFP a summary of project activities will be provided on a quarterly basis to include a list of completed and pending task activities, along with identification of any issues or problems that may exist. In addition, corrective actions identified but not yet completed affecting outstanding task orders will be listed.

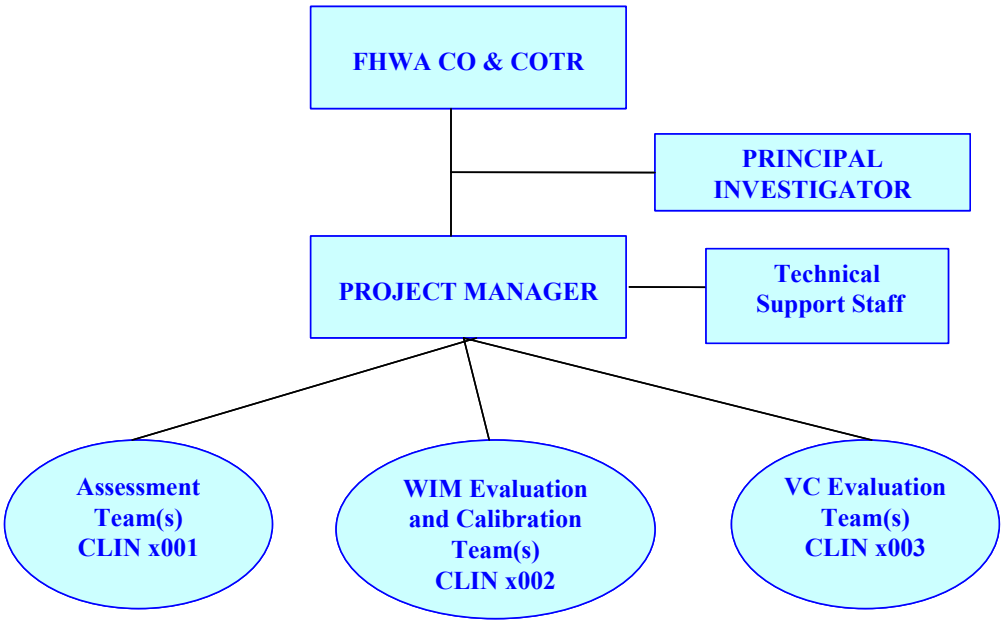
MACTEC proposes to create a web page for this project. This web page will provide access to current schedules, project data and site reports for the MACTEC team. FHWA staff involved in the project and others identified by FHWA will be given access to the page.

Who will do the work?

The work on this contract is to be done primarily by staff from MACTEC and Digital Traffic Systems (DTS). The team will also have vendors to provide drivers, tractors, trailers, loads and travel services.

The team of MACTEC and Digital Traffic Systems (DTS) has a significant number of highly qualified staff with experience in the range of analyses required and equipment that may be installed at the sites covered by this project. MACTEC staff has experience in performing field assessments, performance evaluations and system calibrations. DTS staff routinely installs, maintains, and collects data from a variety of classification and weight data collection equipment throughout the United States in addition to having specialized video data collection capabilities. Additionally, vendors have been identified who can provide the necessary vehicles for WIM performance evaluations and calibrations on a national basis. When necessary, equipment manufacturers will be contacted to provide support.

The project staff will include a Principal Investigator, a Project Manager, Technical Support Staff, Assessment Teams, WIM Evaluation Teams, WIM Calibration Teams and VC Evaluation Teams as shown in the following figure:



The Principal Investigator will be responsible for initial organization of the project and technical review and oversight of all reports.

The Project Manager will oversee the daily operations on the project and serve as the liaison with FHWA. He will create teams from MACTEC and DTS staff based on task and site requirements. He will coordinate with all applicable vendors and handle all project logistics.

Senior staff on the project will provide technical support. They will provide specialized technical review and oversight in their respective areas. The specialty areas identified for the project are:

- Pavements
- Traffic
- Statistics
- Equipment

Assessment, Evaluation and Calibration Teams will be headed by a Task Leader. Their responsibilities include providing coordination, oversight of field activities, completion of reporting requirements and all task deliverables. In addition to the two primary Task Leaders, other senior staff may function as Task Leaders if more than two teams are required for Task Order completion. Task Leaders will have staff engineers from MACTEC available to undertake handout guide development, analyses and basic report preparation. They will have WIM specialists from DTS for equipment diagnostics, calibration and data collection and reporting. Staff engineers and WIM specialists will be tasked according to the task requirements for a site and the type of installed equipment. Every effort will be made to maintain agency continuity through Task Leader assignments.

The Task Leaders will work in concert with Regional Support Contractors (RSCs) and highway agencies to obtain the best available information on the data being collected.

When will the work be done?

It is expected that task orders will be issued according to the terms of the RFP as verification is obtained that the equipment is working. Sites for which a Task 1 assessment or a Task 3 evaluation is requested will be completed within 90 days of receipt of the assignment. Sites for which a Task 2 evaluation or calibration is requested will be completed with 120 days of receipt of the assignment.

In cases where the profile data is not readily available, we propose to submit amended reports updated with respect to smoothness and recommendations on secondary equipment, after data is received. We will not delay issuing the initial report.

TASK 1 – CONDUCT A WIM AND VC SYSTEM FIELD ASSESSMENT

Under this task, field assessments will be conducted of working WIM and VC systems to determine if there are any problems that need to be corrected prior to conducting an on-site evaluation with vehicles or extended video data collection. This is the item identified in the RFP Scope of Work as Conduct WIM and VC System Field Assessment (assessment).

An assessment may be limited to the LTPP lane or include an additional WIM that may be used to provide data for the same SPS project. It also collects all of the basic information necessary to conduct a site evaluation. Traffic classification, loading data and profile data for a WIM location are reviewed. Traffic classification and past loading data are reviewed for a VC system location. The assessments will identify sites that are expected to have successful evaluations under either Task 2 or 3, or corrective actions to make sites eligible for such activities. The assessments will also provide an indication of the quantity and probable quality of the data based on site

conditions. It also may indicate that sufficient data and information are available to certify SPS-8 sites for reduced or discontinued monitoring.

Work under this task is not intended to determine the locations of new WIM or VC systems. The sites however may include those for which an upgrade or replacement has been identified.

The results of an assessment are summarized in a report that briefly discusses site conditions, results of analyses and makes a recommendation as to the actions to be taken next for the site. The recommended actions, whether to conduct an evaluation or to undertake some type of site remediation are supported with analyses contained in the report.

The Task Leader is responsible for the organization of task activities, content of the handout guide, site recommendations, preparation of the summary report and all other task deliverables. Staff engineers will be used on an as needed basis for the collection, evaluation, analysis and reporting on the data collected prior to the visit, as well as the integration of field notes and results into the report. Field personnel will be individuals familiar with the site's equipment, software, maintenance and capabilities. The field personnel verify equipment condition, collects pavement condition information, operates video equipment to check vehicle pavement interactions and classification, performs speed data collection, and downloads any supporting data required to determine if the data meets the performance criteria. The size of a field crew will depend on site considerations including pavement condition, equipment type, site familiarity and prior interaction with the agency.

The Task Leader has as resources the Project Manager, the Senior Pavement Engineer, the Senior Traffic Engineer, the Senior WIM Specialist, and the Statistician. The senior staff will review all reports and recommendations. The Senior Traffic Engineer will support reviews of available traffic data. The Senior Pavement Engineer will provide support on distress and profile issues. The Senior WIM Specialist will identify additional manufacturer or vendor support that may be needed in an evaluation. The Statistician will prepare site-specific sampling plans. The Project Manager will be involved in staff scheduling, vendor coordination, and travel arrangements.

Deliverables

There are four deliverables associated with this task: master schedule updates, WIM Site Inventory (LTPP Traffic Sheet 17), the WIM Site Coordination and Location Handout Guide (handout guide) and an assessment report.

A task order for an assessment will result in a site-specific addition to the master schedule on receipt of the request. The schedule update will reflect the typical tasks of pre-visit coordination, preliminary analysis, data acquisition, the site visit and the reporting deadline for the site including whether an additional system was requested. Each site-specific portion of the schedule will be modified as site visits are confirmed. Updated master schedule information will be available to the FHWA on a monthly basis. The schedule will also be accessible through the project's web page.

LTPP Traffic Sheet 17, WIM Site Inventory, (Sheet 17) contains information on the location of the equipment, data on the surrounding pavement, the equipment type and installation, and visual records of the equipment and its location. The sheet will initially be completed during pre-visit coordination with both the RSC and the highway agency. It will be provided as part of the handout guide and the assessment report. A copy will be posted to the project's web page for ready reference.

The handout guide is a quick reference to the schedule of activities and site information. It is also core information for the conduct of site evaluations. A copy of the guide will be provided to the FHWA, the highway agency contact(s), the relevant FWHA Division Office, and the applicable RSC a minimum of 7 days prior to the assessment. It will typically include an agenda, points of contact, maps to locate the equipment, airport, meetings, scales, and the web page addresses for assessment and evaluation procedures and equipment information. Much of the relevant information is contained in Sheet 17 and in LTPP Traffic Sheet 18, WIM Site Coordination (Sheet 18). A copy of the handout guide will be posted to the project's website for ready reference.

The assessment report is due 15 days after the assessment is complete in three copies (one hard copy to the CO and one hard copy and one electronic copy to the COTR). Completion of the assessment is defined as the end of the site visit. Missing profile data will result in submission of an amended report subsequent to receipt of the missing data.

Included in the report will be an executive summary of the highlights, findings and recommendations for any corrective actions and supporting documentation. Supplemental information may include commentary on the probable quality and sufficiency of existing data, computations for smoothness, comments on equipment diagnostics and possible maintenance needs, or pavement maintenance needs.

CLIN x001A - Process for the LTPP Lane Only

An assessment for the LTPP lane is used to make a determination as to whether a site evaluation is feasible and if previously collected data can be used to meet the requirement of five years of research quality data. The following is a prototype of the master schedule entry for this CLIN.

PHASE	ITEM	DURATION OR DEADLINE
PRE-VISIT	**INTERNAL COORDINATION**	From receipt of Task Order (TO) to report submission
	Project Setup	Within 5 working days of receipt of TO
	Work Assignment	Within 10 working days of receipt of TO
	Traffic Data Request	Response due at least 21 days prior to site visit (from LTPP Customer Support)
	Visit Confirmation	Within 21 days of receipt of TO
	Travel Arrangements	Complete at least 21 days prior to site visit
	RSC Coordination	Within 14 days of receipt of TO through site visit
	Agency Contact	Within 21 days of receipt of TO
	Profile Data Request	Response due at least 7 working days prior to site

PHASE	ITEM	DURATION OR DEADLINE
		visit
	Traffic Data Request	Response due at least 21 days prior to site visit
	Notification of Visit Date	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Confirmation of Equipment Status	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Agency Coordination	
	Meeting date	Within 30 days of receipt of TO
	Visit date	Within 30 days of receipt of TO
	Traffic Data Request	Response due at least 14 days prior to site visit
	Other (permits, traffic control)	Complete at least 14 days prior to site visit
	Confirmation of Visit	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Confirmation of Equipment Status	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Profile Data Analysis	2 working days
	Traffic Data Analysis	3 working days
	Handout Guide	
	Handout Guide development	21 days
	Handout Guide Distribution	7 days prior to site visit
ON-SITE		Complete at least 21 days prior to end of Task deliverable period
	Agency Briefing	Included in Site work
	Site Work & Travel	3 days
POST-VISIT		Complete within 15 days of end of site visit
	Profile Data Analysis	1 day (if not previously completed)
	Traffic Data Analysis	2 days
	Report Writing	7 days
	Report Review and Revision	4 days
	Report Submission	No later than15 days after site visit
	Amended Report	Within 15 days of receipt of data

Pre-visit activities

There are six basic activities as a part of the pre-visit activities: internal coordination, RSC coordination, agency coordination, profile evaluation, traffic data evaluation and handout guide creation. Coordination activities will be documented in a consistent fashion. Notification of completion of RSC and agency coordination will be provided electronically via task updates in the master schedule.

The agency contact for the site and the RSC will be contacted for verification of operational equipment status of the equipment and confirmation of the evaluation visit at the following stages:

- Within 10 days of receipt of the Task Order (Project Manager)
- 30 days prior to the site visit (Task Leader)
- 1 week prior to site visit (Task Leader)
- 1 working day prior to mobilization to the site (Task Leader)

Internal coordination

This is the responsibility of the Task Leader and includes maintenance of site schedule information on the master schedule. The Task Leader will identify staff and travel requirements, locate all previously collected information on the site, and identify data deficiencies to be remedied through the RSC and agency coordination processes. The Task Leader will work with the Project Manager to most efficiently schedule staff and travel.

The Task Leader will request from LTPP Customer Support all currently available data relating to monitored traffic in the LTPP databases. This will include classification, weight and equipment data from the traffic database and previous calibration information from the pavement performance database.

RSC Coordination

RSC coordination is a sub-task on the master schedule. This activity will be the responsibility of the Task Leader. The two most critical items from a timeliness perspective are the agency contact(s) and profile information. The agency contacts are needed to coordinate site visits, arrange access to the equipment and any other assistance that may be needed from the agency to support the evaluation. The profile information is needed to make a smoothness determination. If the site has not been or will not be profiled in the year ending 30 days prior to the TO, then profiling will be requested of the RSC. If conflicts exist that preclude getting the data by the site visit, FHWA will be notified.

Coordination activities will also include requesting the basic data for Sheet 17 in addition to information on equipment status and history. A photograph will be requested with the LTPP lane identified and the number and direction assigned to that lane for traffic data collection purposes (both LTPP and agency) requested. In addition, information will be requested for on-site activities already scheduled by the RSC or agency that could affect traffic patterns around the equipment location.

If the RSC is responsible for directly downloading traffic data from the site, a copy of the information in a format that includes speed information by vehicle classification and time of day will be requested. This may be ASCII files that require further manipulation or reports already programmed into the equipment that may be scanned for inclusion in the

site evaluation report. When such data is available, a minimum 7-day interval will be requested.

The RSC will be notified when a site visit is confirmed so that they may be aware of potential future scheduling conflicts.

RSC coordination will be documented in a consistent fashion. A sample form is shown in Figure 1. The completion of the coordination activities, defined as the receipt of all requested data, will be noted on the master schedule.

RSC Contact/Coordination - SPS WIM

Region: _____ Contact: _____

Phone: _____ e-mail: _____

Team Leader: _____

Site: _____ Visit Date: _____

Task Order: _____ Region notified: _____

Due: _____

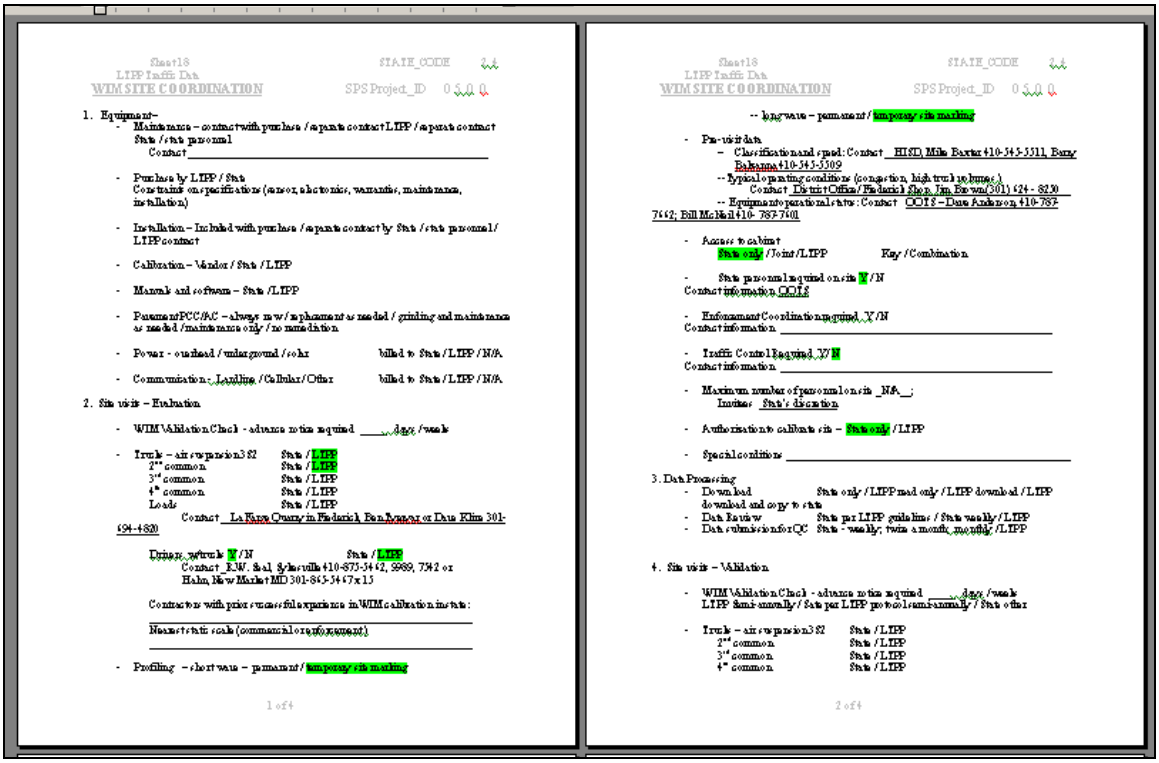
	Requested	Due	Received	Notes
Agency Contact:				
Sheet 17 data:				
Site Photo:				
Profile:				
Traffic:				
RSC on-site:				

Comments:

Figure 1 Proposed RSC Contract Record

Agency Coordination

The Task Leader executes this activity. Agency coordination is a sub-task on the master schedule. While the key piece of information is the available dates for site visits other items will be needed. One of the first is a review and update, if needed, of the contact information for the agency using a Sheet 18 or similar form. An example of the initial pages of a Sheet 18 is found Figure 2. Subsequently, with confirmation of the agency's contact for the site and access to the equipment, the information on the Sheet 17 will be reviewed and updated as needed and a date for the assessment established. The date selected will reflect any requirements for agency staff participation, holidays or special events or activities that might significantly influence the fleet mix, possible weather conditions and the 90-day deadline from the initiation of the request. The agency will also be asked to provide any traffic control or signing normally required for roadside activities. This may also affect the scheduling.



Sheet18 STATE_CODE
LTPP Traffic Data
WIM SITE COORDINATION SPS Project_ID 0 5 0 0

1. Equipment–
- Maintenance – contract with purchase / separate contract LTPP / separate contract State / state personnel
  Contact _____
- Purchase by LTPP / State
  Constraints on specifications (sensor, electronics, warranties, maintenance, installation)
- Installation – Included with purchase / separate contract by State / state personnel / LTPP contract
- Calibration – Vendor / State / LTPP
- Manuals and software – State / LTPP
- Pavement PCC/AC – always new / enhancement as needed / grinding and maintenance as needed / maintenance only / no remediation
- Power - overhead / underground / solar billed to State / LTPP / N/A
- Communication - Landline / Cellular / Other billed to State / LTPP / N/A

2. Site visit – Evaluation
- WIM Validation Check - advance notice required ____ days / weeks
- Trunk – air suspension 3 S2 State / LTPP
  2nd common State / LTPP
  3rd common State / LTPP
  4th common State / LTPP
  Loads State / LTPP
  Contact La Farge Quarry in Frederick, Penn Aggregates or Dale Klim 301-694-4820
- Driver w/truck Y / N State / LTPP
  Contact K.W. Beall, Sykesville 410-875-3442, 9989, 7542 or Helm, New Market MD 301-845-3447 x 13
- Contractors with prior name, full experience in WIM calibration in state:
  _____
  Name; static scale (commercial or enforcement)
  _____
- Profiling – short wave – permanent / temporary / tie marking

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Sheet18 STATE_CODE
LTPP Traffic Data
WIM SITE COORDINATION SPS Project_ID 0 5 0 0

-- long wave – permanent / temporary / tie marking
- Pre-visit data
  – Classification and speed: Contact HISD, Mike Baxter 410-545-5311, Barry Balsamo 410-545-5309
  -- Typical operating conditions (congestion, high truck volumes)
  Contact Electric Office/Frederick Shop, Jim Brown (301) 624 - 8230
  -- Equipment operational status: Contact COTS – Dana Anderson, 410-782-7462; Bill McNeil 410- 782-7401
- Access to cabinet
  State only / Joint / LTPP Key / Combination
- State personnel required on site Y / N
  Contact information COTS
- Enforcement Coordination required Y / N
  Contact information _____
- Traffic Control Required Y / N
  Contact information _____
- Maximum number of personnel on site _N/A_;
  Invites State's discretion
- Authorization to calibrate site – State only / LTPP
- Special conditions _____

3. Data Processing
- Download State only / LTPP mod only / LTPP download / LTPP download and copy to state
- Data Review State per LTPP guidelines / State weekly / LTPP
- Data submission for QC State - weekly, twice a month, monthly / LTPP

4. Site visit – Validation
- WIM Validation Check - advance notice required ____ days / weeks
  LTPP Semi-annually / State per LTPP protocol semi-annually / State other
- Trunk – air suspension 3 S2 State / LTPP
  2nd common State / LTPP
  3rd common State / LTPP
  4th common State / LTPP

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Figure 2 Sample LTPP Traffic Sheet 18 - pages 1, 2

The initial assessment provides an opportunity for a hands-on introduction to the project, the staff and the processes involved in assessment and evaluation. An offer will be made for a meeting between agency staff and assessment personnel as a part of the process. Such a meeting will include a general overview of the project as a whole and for the agency in particular, describe the process and address, to the extent possible, the agency concerns about the process. The results of the assessment will not be provided at the meeting, (even if held after the site visit) so that the information and recommendations can be completely reviewed and discussed with FHWA first.

Agency coordination includes requesting information on equipment status (working or not, new or not) including any recent equipment maintenance or calibration activities and the classification scheme and or algorithms currently in place. The classification scheme is information on the numbers of axles and body combinations that define the classes reported by the equipment. The information on the classification scheme will be used to refresh staff on other than FHWA Traffic Monitoring Guide (TMG) schemes, as well as providing a basis for determining whether the equipment correctly classifies vehicles. The classification algorithm is the information used in the equipment's software to bin vehicles by number of axles, vehicle length, axle spacing, and axle weight characteristics. This must be known to define what constitutes a classification error at the site. This information will also be used to diagnose excessive failures and determine if calibration is possible, or an algorithm modification will be required to obtain better results.

If the RSC is not in a position to provide information with respect to speed and weight for the site, a copy of that information in a format that includes speed information and vehicle specific data will be requested from the appropriate agency contact. The data may be in ASCII files that require further manipulation or reports already programmed into the equipment that may be scanned for inclusion in the assessment report. When such data is available, a minimum 7-day interval will be requested.

A query will also be made as to on-site activities resulting in lane closures that may already be scheduled for pavement maintenance, rehabilitation or other activities that could affect traffic patterns in the vicinity of the equipment.

Agency coordination is not limited to the highway agency but may include others that need to be contacted to obtain the necessary permits for vehicles and work in the right-of-way.

Agency contacts will be documented in a consistent fashion. A sample contact record is shown in Figure 3. The completion of all initial liaison activities, as defined by the confirmation of a site visit date, will be noted on the master schedule.

SPS WIM Agency Contact Record:

Site: _____ Visit Scheduled for: _____
Task Order: _____ Due: _____ Visit Type: _____

	Who	phone	e-mail
Agency staff:			
Agency field personnel:			
Access to box:			
Emergency contact:			

	Date	PM/Task Leader	Agency Contact
Equipment condition:			
Within 10 days of TO			
30 days prior			
1 week prior			
1 working day before mob			

Classification Scheme: _____

Class Algorithm requested: _____ Due: _____ Received: _____
Speed Data requested: _____ Due: _____ Received: _____
Sheet 17 review requested: _____ Due: _____ Received: _____

Safety equipment required: _____
Traffic control requirements: _____
Time of day restrictions: _____
Permitting: _____

Other agencies to be notified:

Figure 3 Proposed Agency Contact Record

Profile Evaluation

The profile evaluation serves to determine if the pavement conditions will prevent obtaining research quality data. Profile data will have been requested from the RSC along with any sectioning information that may be required. All available data at the time of the assessment will be considered for analysis including prior smoothness assessments. The data may be the five runs per wheel path for routine LTPP profiling for information collected prior to the implementation of the SPS WIM profiling directive or the runs from multiple transverse locations specifically collected for pavement smoothness evaluations at LTPP WIM sites. In either case, the data will be analyzed using the LTPP WIM smoothness index. The LTPP WIM Smoothness Index provides a qualitative measure of the likelihood for a working, unbiased WIM installation to produce research quality data as a function of pavement smoothness. The index indicates if the scale should produce research quality data, or if it is not worth doing a site evaluation without addressing pavement deficiencies. The results contribute to the recommendation for site evaluation or remediation. The index values will be included in the assessment report in a fashion similar to that in Figure 4.

Profiler Passes			Pass 1	Pass 2	Pass 3	Pass 4	Pass 5	**Ave.**
Center	LWP	LRI (m/km)	*1.319*	*1.473*	*1.201*	*1.560*	*1.644*	***1.439***
		SRI (m/km)	*1.384*	*1.422*	*1.185*	*1.579*	*1.617*	***1.437***
	RWP	LRI (m/km)	*2.076*	*2.159*	*1.157*	*1.702*	*1.736*	***1.766***
		SRI (m/km)	*0.792*	*0.974*	*1.049*	*1.104*	*1.009*	***0.986***
Left Shift	LWP	LRI (m/km)	*1.107*	*1.253*	*1.294*	*1.274*	*1.322*	***1.250***
		SRI (m/km)	*1.577*	*1.598*	*1.662*	*1.699*	*1.515*	***1.610***
	RWP	LRI (m/km)	*1.201*	*1.488*	*1.785*	*1.788*	*1.845*	***1.621***
		SRI (m/km)	*0.871*	*1.005*	*1.171*	*1.074*	*0.917*	***1.008***
Right Shift	LWP	LRI (m/km)	*1.759*	*1.461*	*1.116*	*1.137*	*1.176*	***1.330***
		SRI (m/km)	*0.815*	*0.837*	*0.862*	*0.864*	*0.803*	***0.836***
	RWP	LRI (m/km)	*1.072*	*1.288*	*1.254*	*1.243*	*1.101*	***1.192***
		SRI (m/km)	*0.850*	*1.088*	*1.113*	*1.116*	*0.958*	***1.025***

Figure 4 Sample Outcome from WIM Smoothness Index Evaluation

(Threshold Maximum.789)

Profile evaluation will be done by the staff engineer and reviewed by the Task Leader and the Senior Pavement Engineer.

Traffic Data – Historical

The evaluation of historical data is undertaken to provide a record of the quantity and consistency of previously collected classification and weight data with respect to LTPP traffic data requirements. The SPS comparison features of the LTPP Traffic Analysis software and or the TRFNUMCHEK procedures will be used to review the data for consistency over time. An example of the SPS comparison features illustrating tracking the expected percentage of Class 9 trucks at the site is shown in Figure 5.

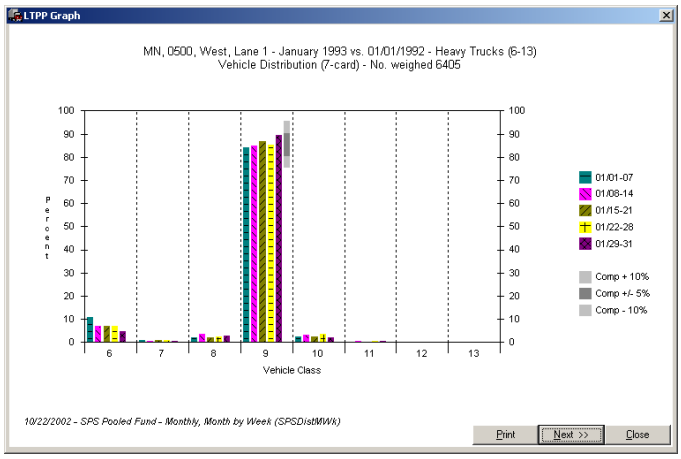


Figure 5 Sample - Vehicle Distribution by Class by Week vs. Expected Range

The classification information will be reviewed through the LTPP traffic analysis software. One of the principal items of interest is the day of week distribution patterns for trucks. To verify classification algorithms it is desirable to have as great a variety of vehicles as possible to look at by-class differentiation. An example of the graphs used to review this information is shown in Figure 6. This information will influence recommendations pertaining to VC system evaluation scheduling. The by-month and by-year trends over the project to date will indicate if seasonal patterns exist. They may also indicate the potential of past classification data to be accepted as research quality if there has been no intervening equipment upgrade or replacement.

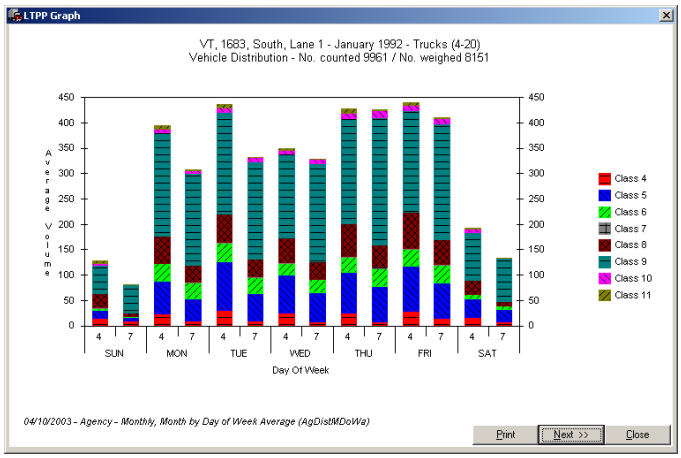


Figure 6 Sample - Vehicle Distribution by Class by Day of Week

The data available may or may not have information from which to compute the percentage of unclassified vehicles. As types of truck misclassifications can only be addressed if the individual truck records can be directly compared to the actual vehicle, such investigations will be limited to data collected while on site. A brief commentary on

the quantity of available data, truck distribution patterns and any unusual site characteristics will be included in the assessment report.

The WIM information will also be reviewed using the LTPP traffic analysis software. The LTPP traffic analysis software will be used to perform trend analyses on past data. The trends reviewed will include:

- multi-year plots of average monthly Equivalent Single Axle Loads (ESALs) (Figure 7),
- average daily steering axle weights,
- gross vehicle weight (GVW) distributions by month within a year (Figure 8)
- GVW distributions over multiple years by year for Class 9 vehicles.

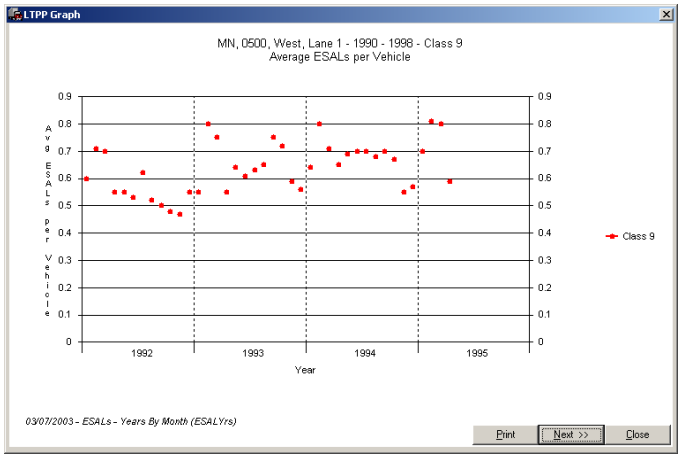


Figure 7 Sample - Average ESALs by Month for Available WIM Data

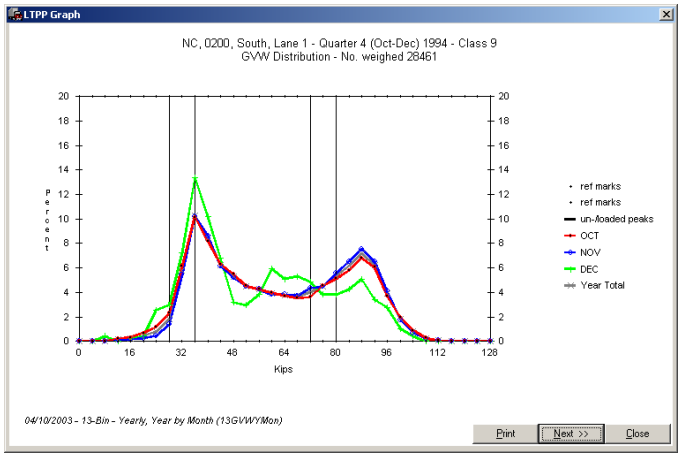


Figure 8 Sample - GVW for Class 9s by Month

For SPS-8 sites where WIM data is available, the GVW on a year-to-year basis for the dominant truck class will be reviewed. Commentary and selected graphs will be provided in the assessment report to discuss the sufficiency of the data to meet the requirement for five years of quality WIM data. In addition, vehicle distributions for truck counts will be

run through the same analysis as for the classification data. This will occur whether or not classification data exists.

Historical data that has not been processed into the LTPP traffic database will not be reviewed.

Historical data will be investigated by the Staff Engineer subject to review and direction of the Senior Traffic Engineer and or Principal Investigator.

Traffic Data Analysis – Current

Current data is considered to be data collected with 30 days of the Task Order assignment. A minimum 7-day and preferably 30-day data set will be obtained. Both classification and weight data files will be requested from the agency or RSC as appropriate during the coordination process. The data will be processed through the LTPP traffic software programs. A determination will be made if there has been a change in fleet or equipment operations with respect to historical or expected statistics. From this data the following items are expected:

- Current GVW distributions for Class 9 vehicles,
- Current axle weight distributions for Class 9 vehicles, and,
- Vehicle distributions by day of week.

Data received from agencies in other than a FHWA TMG format will not be evaluated.

Current Class 9 GVW distributions and average front axle weights will be reviewed to determine if possible calibration problems exist. The axle distributions will be reviewed to see if unusual numbers of very light or very heavy axles exist or, if auto-calibration is being used, how variable the target weight is. Class 9 steering axle weights will be reviewed to see if the site averages are significantly different from historical or expected values.

Current vehicle class distributions by day of week will be created for the total population, the truck population, Class 9s, and any other truck class that constitutes more than ten percent of the truck population. Commentary will be provided on the best days to find specific vehicle classes. This is the reason for the day of week stratification of the distributions. This information will be compared to equivalent samples of historical information as input to the discussion on the consistency of the information over time.

Speed-by-hour distributions, if available, will be used to determine the probable range of speeds observed in the field. This data will be requested in the standard report form provided by the installed equipment. The information will be used to identify periods of congestion. This information sets the bounds for test truck speeds. It will also be used to look at the percentage of speeds over the posted limit to identify where the speed limit will prevent test trucks from moving at the typical speed. The distributions will be reviewed for weekdays and weekends.

When speed reports, invalid weight records, and unclassified vehicle counts are requested, a due date will be agreed to with the responsible party. This due date should be at least 14 days prior to the site visit. Follow-ups on late data will be conducted on a weekly basis until receipt or the site visit whichever comes first. If the data is not received prior to the site visit, samples of speed and classification data will be collected on site to use as substitutes. If the requested data is received by the end of the site visit, its analysis will be completed and included in the assessment report. If this data is not received by the end of the visit, the only current data elements for the site to be evaluated will be speed distributions for the truck populations and an estimate of the percentage unclassified using samples collected on site.

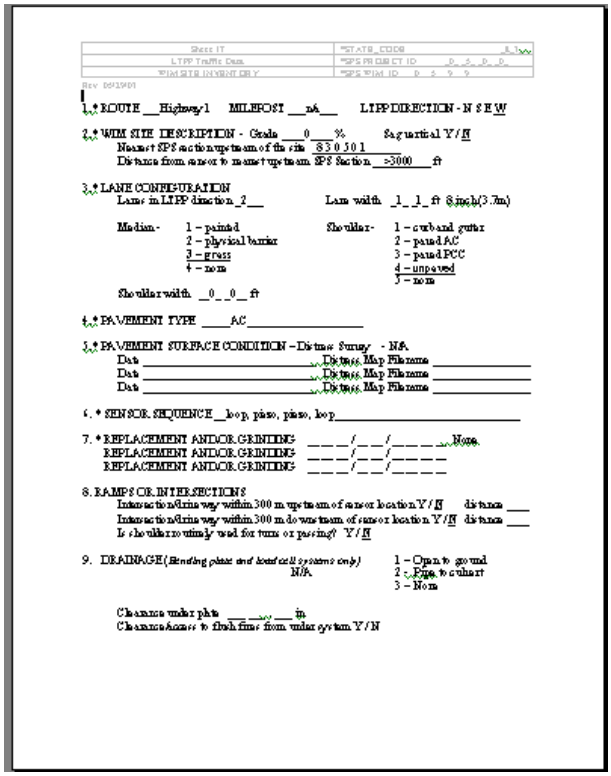
Handout Guide

The handout guide is a quick reference to the schedule of activities and site information. The initial version provided prior to the site visit will contain a schedule of events, points of contact, map, web addresses relevant to the site, and equipment information. The schedule of events will include site activities (including any meetings), the start time and the minimum expected time on site as well as weather delay information. Points of contact will include agency and assessment personnel, the relevant FHWA personnel, and individuals or organizations to contact in the event of an emergency. This information will supplement a Sheet 18. Maps will be included for the WIM site location, the airport(s) that can be used, meeting locations and scale locations. In addition, maps of possible truck routes and route restrictions will be prepared. Where necessary, maps will be supplemented with driving instructions, times and landmark descriptions or photos. The LTPP web page address for SPS Traffic Pooled Fund Study will be included in the handout guide to provide information on the project and associated procedures. The project web page address will also be included so that interested individuals may check for updates to the schedule and handout guide. The current Sheet 17 will contain location and pavement information as well as the information that has been accumulated on equipment to that point.

The Staff Engineer will prepare a rough draft of the handout guide from available material. The Task Leader will complete it, have it reviewed and be responsible for its distribution.

Handout Guide – Proposed Outline

Page 1 – Site Name, General Location Map, Visit Date and Type
Page 2 – Points of Contact: Assessment Team, Highway Agency, FHWA COTR, FHWA District Office Liaison, emergency numbers, LTPP SPS WIM web page, web page for project
Page 3 – Agenda (travel, briefing(s), on-site period, truck route check)
Page 4 – Map and directions for airport, meeting room(s), site, scales
Page 5 – Truck route map(s) with scale location and route restrictions
Page 6 to end – Sheet 17 with site photos currently available



Sheet 17 | *STATE_CODE | LTPP Traffic Data | *SPS PROJECT ID | *PIM STR INVENT DR Y | *SPS TPIM ID

Rev 04/13/01

1.* ROUTE Highway 1 MILEPOST NA LTPP DIRECTION - N S E W

2.* WIM SITE DESCRIPTION - Grade 0 % Sag vertical Y/N
Nearest SPS section upstream of this site 830501
Distance from sensor to nearest upstream SPS Section >3000 ft

3.* LANE CONFIGURATION
Lanes in LTPP direction 2 Lane width 1 1 ft 8 inch(3.7m)

Median - 1 – painted
2 – physical barrier
3 – grass
4 – none

Shoulder - 1 – curb and gutter
2 – paved AC
3 – paved PCC
4 – unpaved
5 – none

Shoulder width 0 0 ft

4.* PAVEMENT TYPE AC

5.* PAVEMENT SURFACE CONDITION – Distress Survey - N/A
Date Distress Map Filename
Date Distress Map Filename
Date Distress Map Filename

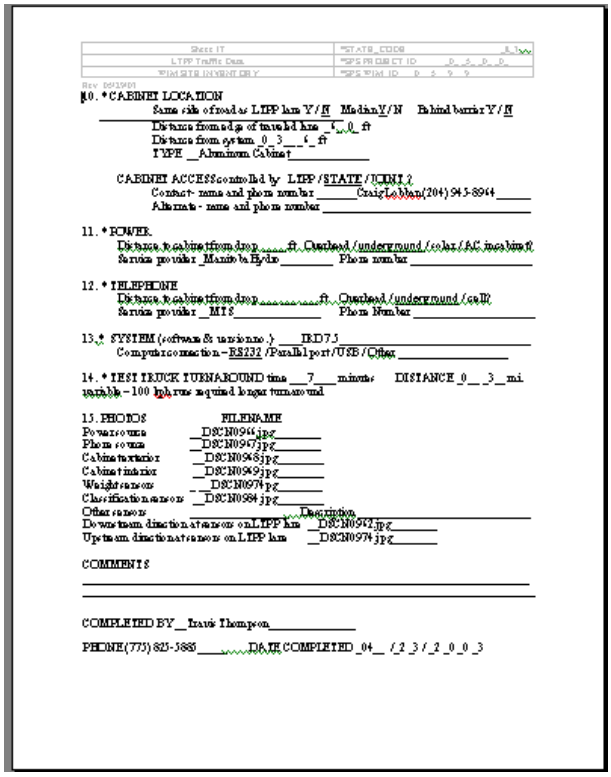
6. * SENSOR SEQUENCE loop, piezo, piezo, loop

7. * REPLACEMENT AND/OR GRINDING ___/___/_____ None
REPLACEMENT AND/OR GRINDING ___/___/_____
REPLACEMENT AND/OR GRINDING ___/___/_____

8. RAMPS OR INTERSECTIONS
Intersection/driveway within 300 m upstream of sensor location Y/N distance ___
Intersection/driveway within 300 m downstream of sensor location Y/N distance ___
Is shoulder routinely used for turns or passing? Y/N

9. DRAINAGE (Standing plastic and board cell systems only)
N/A
1 – Open to ground
2 – Pipe to culvert
3 – None

Clearance under plate ___ in
Clearance/Access to flush fines from under system Y/N



Sheet 17 | *STATE_CODE | LTPP Traffic Data | *SPS PROJECT ID | *PIM STR INVENT DR Y | *SPS TPIM ID

Rev 04/13/01

10. * CABINET LOCATION
Same side of road as LTPP lane Y/N Median Y/N Behind barrier Y/N
Distance from edge of traveled lane 6 0 ft
Distance from system 0 3 6 ft
TYPE Aluminum Cabinet

CABINET ACCESS controlled by LTPP/STATE/TCHNL?
Contact - name and phone number Craig Lobban (204) 945-8944
Alternate - name and phone number

11. * POWER
Distance to cabinet from drop ft Overhead/underground/solar/AC meabinet
Service provider Manitoba Hydro Phone number

12. * TELEPHONE
Distance to cabinet from drop ft Overhead/underground/cell
Service provider MTS Phone Number

13.* SYSTEM (software & version no.) IRD 7.5
Computer connection – RS232 /Parallel port/USB/Other

14. * TEST TRUCK TURNAROUND time 7 minutes DISTANCE 0 3 mi.
variable – 100 kph runs required longer turnaround

15. PHOTOS FILENAME
Power source DSCN0945.jpg
Phone source DSCN0947.jpg
Cabinet exterior DSCN0948.jpg
Cabinet interior DSCN0949.jpg
Weight sensors DSCN0974.jpg
Classification sensors DSCN0984.jpg
Other sensors Description
Downstream direction at sensors on LTPP lane DSCN0942.jpg
Upstream direction at sensors on LTPP lane DSCN0974.jpg

COMMENTS

COMPLETED BY Travis Thompson

PHONE (775) 825-3885 DATE COMPLETED 04 / 2 3 / 2 0 0 3

Figure 9 Sample Traffic Sheet 17, page 1

Figure 10 Sample Traffic Sheet 17, page 2

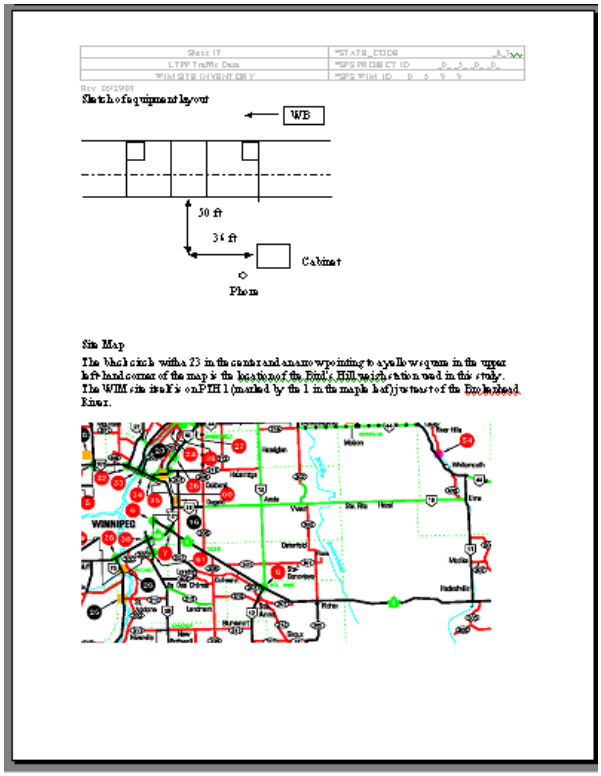


Figure 11 Sample Traffic Sheet 17, page 3

On-site activities

The visit to the equipment location is the means by which all of the information gathered on the site, equipment and data can be verified in preparation for a recommendation on doing an evaluation.

The on-site staff will have, in addition to the handout guide, a laptop computer with the cabling and software required to access the equipment, a radar gun, a multi-meter, a digital camera, a video data camera and documentation on the classification scheme.

Agency interaction

Agency interaction for a site visit consists of two elements: a briefing for agency staff who may or may not be directly involved in on-site activities, and briefing and coordination with staff who will provide access to the equipment and any other previously agreed to support. The former briefing is at the agency's option.

Equipment Diagnostics

Equipment diagnostics include validation or completion of Sheet 17 information, speed and spacing verification, coarse weight verification, checking software and cabling requirements and checking download and video capture capabilities.

In addition to the checks conducted inside the cabinet, sensor connections and installation conditions will be checked. Deficiencies will be documented with digital photographs.

Information on the diagnostics done will be included in the assessment report along with potential equipment maintenance needs.

The speed and spacing verification process will be done to support verification of vehicle classification. As a part of the process, if the truck speed ranges are not available through other data acquisition efforts, a 100-truck sample will be taken. Then this information will be available to help define speed ranges for an evaluation. Spacing checks will be done using the drive tandems of tractors. These are expected to have a distance of 4.2 to 4.4 feet.

Coarse weight verifications will be performed using a front axle weight method at sites with working WIM equipment. A truck sample will be taken and front axle weights will be compared with historical data from the site to determine if a significant amount of drift has occurred. If it has been determined that historical data is not reliable, the sample will be compared with the industry standard used for the WIM equipment's self-calibration operation (typically 10,300 pounds). If either of these methods identify that a considerable drift from normal weights has occurred, a calibration of the system will be deemed necessary.

The results of the spacing and weight verifications will be documented. The possibility of calibration as a part of the evaluation process will be discussed.

Pavement Conditions

Pavement condition assessments involve a survey of the pavement in the LTPP lane and observation of trucks moving in the lane through the WIM section. This section, 275 m prior to the scale and 30 m after it, is considered to be the influence area for vehicle dynamics at the scale. The survey will not be a complete distress survey due to the lane closure requirements typically associated with such activities. It will, however, include a walk along the shoulder (if it exists) to identify potholes, faulting, patches that are not flush with the surface or rutting that may affect vehicle dynamics. The survey may be done during the site visit or a video of the section may be subsequently reviewed in the office. Distresses will be qualitatively evaluated using the definitions in LTPP's Distress Identification Manual. If there is no shoulder, review will be limited to a windshield survey. Photographs will be taken at locations where problems are evident. Particular attention will be paid to evidence of rutting in the vicinity of the scale. Information on pavement condition will be entered in Item 5 of Sheet 17 and discussed in the assessment report.

Observations will be made of trucks traveling in the lane to look for bouncing that may not be dampened by the time the vehicle crosses the scale. At least 15 minutes of video or 25 Class 9s will be filmed for future reference. Particular attention will be paid to vehicles as they pass within the last 40 m prior to the scale.

Classification Evaluation

An initial check of the classification algorithm will be made as a part of the site assessment to identify any gross errors in the equipment and any differences in the information provided on the scheme used versus that actually in place. The verification will be done by collecting video at the site for later review. The recording will have one to three hours of data depending on the truck volume at the site to obtain preliminary estimates of error rates.

It is expected that most of the sites evaluated will have the capability to provide real time capture of classification data (vehicle by vehicle classification). As a result, a *Video/Data Synchronization (VDS) System* will be attached to the equipment to record a picture of the actual vehicle with a date and time stamp and a sequence number. If real time data is not available, the clock of the video camera will be synchronized to match the site equipment's so that a download of the day's data can be compared to the film. The video recording will begin no later than completion of filming to document the vehicle pavement interactions.

Handout Guide Review

The handout guide review consists of two parts, photography of the site to complete Sheet 17 documentation and verifying the maps needed for an evaluation. The map verification includes truck scale locations, amenities such as rest areas, off-site parking for trucks during breaks and running the truck routes. At least three runs will be made of each potential truck route to obtain a round trip time estimate. The estimate of round trip times will be input to the decision on the number of trucks required to efficiently evaluate a WIM site. In addition any conditions affecting access to the equipment and ability to work on at the roadside will be considered and a recommendation made. Such instances will be narrow shoulders where parking a vehicle at the site may influence lane distributions, or equipment located in the median where access may be restricted.

Post-visit activities

After the site visit, sufficient information will be available to make a recommendation on doing a site evaluation. It is during this period that analyses are completed, classification information is checked and the material is updated to form the basis of the next site visit.

Update of Data Analysis

There are three potential areas of data analysis updates: profile, traffic loading and classification data.

Profile analysis will be done in those instances where the necessary information was not received prior to the site visit.

If traffic data was not available prior to the site visit covering a 7 to 30 day interval some time between the issuance of the task order and the site visit, a data sample will have been acquired while on site. This may include either a full set or partial information such as speeds or unclassified vehicles for the duration of the time on site. The analysis for this

data is that of current data. If historical data is provided while interacting with agency personnel, that material will be handed over to the RSC for processing and not included in the assessment process.

The classification video will be checked to determine the percentage unclassified vehicles in the sample and the percentage of misclassified trucks if the information cannot be obtained directly from equipment records. If the video was hooked into the equipment, the percentage unclassified will be computed as the total unclassified on the film divided by the total on film. If the video was taken in standalone mode, the percentage unclassified will be one minus the total reported by the equipment divided by the total on video. This is more accurately a reflection of vehicles missed than unclassified. Depending on the truck volume either all the data in the sample will be reduced or a representative sample will be selected. The sample selection will be based on truck volumes not time.

More important is the use of the video to determine if there are binning errors in the data. A comparison of the equipment's classification to a manual classification will be performed. The following can all be considered errors; a truck classified as a passenger vehicle, a passenger vehicle classified as a truck and a truck assigned to the wrong class. The actual error definition will be based on the agency's classification algorithm.

The result of the classification evaluation will be submitted using a Traffic Sheet 16, Site Calibration Summary (Sheet 16). A discussion of the findings and possible corrective actions will be discussed in the assessment report.

Additionally, the video will be used as a refresher for evaluation staff doing Task 2 and Task 3 evaluations.

Handout Guide and Sheet 17 updates

The handout guide will be revised with updated maps as necessary including travel times and landmarks. Of particularly importance will be the update of the truck route map for use in WIM evaluations. The Sheet 17 update should be substantially completed in the field. Its incorporation into a revised handout guide should be the only necessary post-visit activity.

Assessment Report

The assessment report consists of an executive summary, recommendations on next steps for the site, data analysis for pavement and traffic data, and an updated handout guide. The executive summary, in two pages or less, will discuss site field assessment highlights, findings and recommendations for any problems identified.

The supporting data, profile files, traffic database entries, and similar materials will be available on request. All site material will be stored on CD-ROM for archival purposes. For each site the subdirectory structure will be by deliverable or data type and within those categories by date.

Assessment Report – Proposed Outline

Section 1 – Executive Summary (2 pages maximum)
Section 2 – Corrective Actions Recommended
Section 3 – Equipment inspection and diagnostics
Section 4 – Classification Verification with test truck recommendations
Section 5 – Profile Evaluation
Section 6 – Distress survey and any applicable photos
Section 7 – Vehicle-pavement interaction discussion
Section 8 – Speed data with speed range recommendations for evaluation
Section 9 – Traffic Data review: Overall Quantity and Sufficiency,
SPS Summary Report (Monthly report of key statistics) and
Representative graphs to include:
Vehicle Distribution Evaluations for Classification and Weight Data
ESALs over all years
Average daily steering axle weight graph(s) – historical and current
Class 9 GVW distribution, Month by year
Class 9 GVW distribution, Years by Year
Section 10 – Updated handout guide per outline with Sheet 17 plus all photographs
Section 11 – Updated Sheet 18
Section 12 – Traffic Sheet 16(s) (Classification Verification only)

CLIN x001B – Process for an Additional WIM

A second WIM evaluated for the LTPP lane is as important to the agency as the primary WIM equipment for the LTPP lane. Unless discussions with the agency have indicated lesser requirements, the same quality standards and evaluation process will be done for the second WIM installation. It is assumed this is a completely separate set of equipment and not co-located with the primary WIM. The process for an additional WIM has very little different from the primary WIM. A separate Sheet 17, handout guide and assessment report will be created to underscore the difference in sites and avoid confusion between them. Except in unusual circumstances the same Task Leader will be responsible for both sites.

A separate entry will be made in the master schedule to track the requested assessment. The task outline will be the same as that used for assessing an LTPP WIM or VC system.

An additional WIM will not be evaluated unless an LTPP WIM assessment has been requested for the same SPS project in the same TO.

Pre-visit activities

The non-LTPP WIM will be included in the initial coordination processes.

This site is not expected to have been profiled by the RSC. While agency data could be used, due to the unknown quality and variability of file formats, a request will be made to the RSC to

schedule profiling for the site. The assessment report will be submitted within 15 days of the site visit. It will be followed by an amended report within 15 days of the receipt of the profile data if the profile data is not available prior to the site visit.

No historical data is expected to exist for the site unless it was previously used to supply LTPP loading data. In lieu of an historical analysis, an equipment-to-equipment comparison will be done. The agency will be requested to supply 30 to 60 days of data from both pieces of equipment for the same period. The data will be processed through the LTPP traffic software and the vehicle distributions, Class 9 steering axle distributions and Class 9 GVW distributions by week will be graphed. This information will be provided for reference.

The current data analysis will be done in the same way as for the primary WIM.

A separate handout guide will be prepared for the site.

On-site activities

There is no significant difference in on-site activities for primary and secondary WIM locations. Depending on the relative locations, separate or combined truck routes may need to be considered in reviewing the handout guide maps.

Post-visit activities

There is no difference in post-visit activities for primary and secondary WIM locations except for traffic data analysis. No historical data will be reviewed for the assessment but equipment-to-equipment comparisons will be provided if the data is available by the end of the site visit. A separate assessment report will be prepared for the additional WIM.

TASK 2 – CONDUCT WIM AND VC SYSTEM FIELD PERFORMANCE EVALUATIONS AND CALIBRATIONS

Under this task field evaluations will be conducted of working WIM and VC systems to determine if the data is of research quality. If not, actions will be taken on-site to attempt to calibrate the equipment. Upgrading sensors, software or other components is not part of this task. This Task comprises the items identified in the RFP Scope of Work as Conduct WIM and VC System Field Performance Evaluations and Calibrations.

The evaluation may be limited to the LTPP lane or include an additional WIM that may be used to provide data for the same SPS project. Evaluations with calibration as needed are done on existing equipment. Calibrations are performed at newly installed sites are followed by evaluation and include observation of the installation contractor's calibration activities.

A WIM and VC System Field Performance Evaluation has three basic elements: site coordination, on-site evaluation and calibration, and reporting. Site coordination includes scheduling, verifying information contained in the assessment handout guide including status of the equipment, and arranging for the trucks required by site conditions. The on-site effort includes team briefings, obtaining reference values for the truck measurements, determining the current equipment performance, and calibration and performance validation if the initial

evaluation determines the data is not research quality. At newly installed equipment, the installation contractor will be responsible for the actual calibration and associated computations. The Phase I contractor will observe and document this part of the activity for future reference as well as be responsible for all other Task 2 activities. Evaluations will be conducted according to the specifications contained in the *Data Collection Guide for LTPP WIM Sites*. At the conclusion of site activities, a summary report is prepared detailing on-site activities, updating the handout guide and providing a recommendation on any site remediation that may be indicated.

The team of Task Leader and field crew is responsible for all site activities. The Task Leader is responsible for the organization of task activities, decisions on issues encountered in the field, production of the summary report and all task deliverables. The field crew may include one or more of the following: a WIM Specialist, a Senior Engineer, a fellow Task Leader, a Field Technician or a Staff Engineer depending on the task requirements. At least one member of the field crew will be familiar with the equipment installed on site and its calibration procedures. The field crew verifies equipment condition, checks on the pavement condition, handles equipment for vehicle classification verification, downloads any supporting data required, does on-site analysis of the data and performs calibrations according to the requirements of the task order. Vendors provide tractors, trailers, drivers and other field support. A staff engineer may assist in the collection, evaluation, analysis and reporting on the data collected during the visit as well as the integration of field notes and results into the final report.

Senior staff supports the team with pavement, traffic and equipment expertise for issues arising on site. The senior staff also review the summary reports. A statistician is available to create experimental designs when a fleet other than the basic two trucks is used. Logistics support is coordinated with the Project Manager to efficiently assign staff and vehicles.

Deliverables

There are four deliverables associated with this task: master schedule updates, the WIM Site Inventory (Sheet 17), the WIM Site Coordination and Location Handout Guide (handout guide) and an evaluation report.

A task order for a WIM and VC System Field Performance Evaluation and Calibration (evaluation/calibration) will result in a site-specific addition to the master schedule on receipt of the request. The schedule update will reflect the typical tasks of pre-visit coordination, review of existing site information, truck acquisition, the site visit and the reporting deadline for the site including whether any additional lanes and or an additional system were requested. Each site-specific portion of the schedule will be modified as site visits are confirmed or rescheduled. Updated master schedule information will be available to the FHWA on a monthly basis or as project activities necessitate. The schedule will also be accessible through the project's web page.

Sheet 17 contains information on the location of the equipment, data on the surrounding pavement, the equipment type and installation, and visual records of the equipment and its location. The Sheet 17 information will be verified during pre-visit coordination with both the RSC and the highway agency. It will be provided as part of the handout guide and the evaluation report. A copy will posted to the project's web page for ready reference.

The handout guide is a quick reference to the schedule of activities and site information. A copy will be provided to the FHWA, the highway agency contact(s), the relevant FWHA Division Office, and the applicable RSC a minimum of 7 days prior to the evaluation. It will typically include an agenda, points of contact, maps to locate the equipment, airport, meetings, scales, and the web page addresses for assessment and evaluation procedures and equipment information. Much of the relevant information is contained in Sheet 17 and Sheet 18. A copy will be posted to the project's web page for ready reference.

The evaluation report is due 15 days after the WIM evaluation is complete in three copies (one hard copy to the CO and one hard copy and one electronic copy to the COTR). The evaluation report contains a number of items including an executive summary that in two pages covers the site highlights, findings and recommendation for any problems identified. Attached to the summary is:

- A copy of the handout guide,
- The data collected and equipment adjustments made including documentation of how they were made,
- Supporting evidence of the determination on whether the data meets research quality standards,
- Recommended corrective actions with supporting rationale for sites that are not research quality,
- Statistical reliability of WIM measurements by vehicle class,
- Previous calibration and performance information,
- Traffic data availability and quality,
- Pavement condition information,
- An estimate of future conditions, and,
- Documentation of equipment diagnostics.

The data collected will include the initial evaluation, and the calibration runs and the post-calibration evaluation if the last two are required. The data will be provided in the format of LTPP Traffic Sheet 21, WIM System Test Truck Records (Sheet 21) or something similar, accompanied by the reference weights and spacings. If equipment adjustments are required, copies of all worksheets, calculations and the actual changes to the equipment will be provided. In order to demonstrate whether the data is of research quality, the mean and two standard deviation values for differences in GVW, single axle weights, tandem axle weights, speeds and spacings will be computed for the population as a whole. In addition, the same statistics will be computed for subsets of the population stratified by speed or temperature. The comparison of the three sets of statistics against the thresholds for research quality as shown below will be included in the report. The two standard deviation limits will be computed using either the Normal or Student's t-distribution depending on the sample size being considered.

SPS-1, -2, -5, -6 and -8 Sites	95 %Confidence Limit of Error	Site Values (subset)	Pass/Fail
Loaded single axles	±20 percent		
Loaded tandem axles	±15 percent		
Gross vehicle weights	±10 percent		
Vehicle speed	±1 mph [2 km/hr]		
Axle spacing length	± 0.5 ft [150 mm]		

In cases where the site exceeds one or more threshold values, a recommendation for corrective action and statistics or graphics to support that recommendation will be included. For those vehicle classes included in the evaluation fleet a statistical reliability of the WIM measurements will be reported. For reader reference all available calibration and performance information on the site will be assembled to observe trends. The majority of this information will come from Sheet 16s created to record initial evaluation and post-calibration conditions. Included with the report will be completed Sheet 16s for the just ended site visit. The assembly of past and present performance information will be accompanied by a discussion of trends and the possible future quality of the data. In addition, the report will include documentation of equipment diagnostics.

CLIN x002A – Process for the LTPP lane

The WIM evaluation of an LTPP lane is intended to determine if the site produces research quality traffic data. After verification that the site (that has previously been assessed) is still working, a field crew will oversee running test trucks across the scale. If the site meets research quality standards with unbiased estimates, the site visit will conclude and a summary report written reflecting that fact. If there are adjustments to be made to improve the data quality, they will be made prior to a final evaluation and completion of the summary report. If the site does not meet those standards, a calibration process will be executed ending with a post-calibration evaluation and summary report.

The following is a prototype of the master schedule entry for this CLIN.

PHASE	ITEM	DURATION OR DEADLINE
PRE-VISIT	INTERNAL COORDINATION	From receipt of Task Order (TO) to report submission
	Project Setup	Within 5 working days of receipt of TO
	Work Assignment	Within 10 working days of receipt of TO
	Travel Arrangements	Complete at least 21 days prior to site visit
	Data Analysis	Complete at least 7 days prior to site visit
	Profile Data Analysis	2 working days
	Traffic Data Analysis	5 working days
	Visit Confirmation	Within 21 days of receipt of TO

PHASE	ITEM	DURATION OR DEADLINE
	RSC Coordination	Within 14 days of receipt of TO through site visit
	Agency Contact Verification	Within 21 days of receipt of TO
	Profile Data Request	Response due at least 7 working days prior to site visit
	Traffic Data Request	Response due at least 14 days prior to site visit
	Notification of Visit Date	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Confirmation of Equipment Status	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Agency Coordination	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Visit date	Within 30 days of receipt of TO
	Traffic Data Request	Due at least 14 days prior to site visit
	Other (permits, traffic control)	Complete at least 14 days prior to site visit
	Confirmation of Visit	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Confirmation of Equipment Status	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Vendor Arrangements	
	Drivers	Complete at least 30 days prior to site visit
	Tractors	Complete at least 14 days prior to site visit
	Trailers	Complete at least 30 days prior to site visit
	Scales	Complete at least 14 days prior to site visit
	Handout Guide	
	Review and update	Complete at least 7 days prior to the site visit
	Distribute handout guide	7 days prior to the site visit
	Phase II Contractor (calibrations)	Request minimum 30 days notice of equipment availability
ON-SITE		Complete at least 21 days prior to end of Task deliverable period
	Site Work & Travel	5 days

PHASE	ITEM	DURATION OR DEADLINE
POST-VISIT		Complete within 15 days of end of site visit
	Analysis	
	Profile Data Analysis	1 day
	Traffic Data Analysis	7 days
	Report	15 days
	Report Writing	7 days
	Report Review and Revision	4 days
	Report Submission	No later than15 days after site visit
	Handout Guide	Submitted with report
	Handout Guide update	1 day

Pre-visit activities

There are six basic activities as a part of the pre-visit activities: internal coordination, data review, RSC coordination, agency coordination, truck acquisition, and handout guide revision. If the site is designated as a newly installed WIM system, a seventh activity, coordination with the installation contractor must also occur. Coordination activities will be documented in a consistent fashion. Notification of completion of RSC and agency coordination will be provided electronically via tasks in the master schedule. Notification of coordination with the Phase II contractor will occur in a similar fashion.

The agency contact for the site and the RSC will be contacted for verification of operational equipment status of the equipment and confirmation of the evaluation visit at the following stages:

- Within 10 days of receipt of the Task Order (Project Manager)
- 30 days prior to the site visit (Task Leader)
- 1 week prior to the site visit (Task Leader)
- 1 day prior to mobilization to the site (Task Leader)

When the task involves newly installed equipment, the Phase II contractor will also be contacted.

Internal coordination

This will be done by the Task Leader and includes maintenance of site schedule information on the master schedule. The Task Leader will identify staff and travel requirements, locate all previously collected information on the site, and have the sampling scheme created or reviewed. The Task Leader will work with the Project Manager to most efficiently schedule staff and travel.

Data Review

An assessment report or previous evaluation report should contain substantially all of the information collected about the site including the typical fleet mixes for the day of week and time of year of the evaluation, the most recent profile data, and speed ranges. The fleet mix information will be used for truck acquisition and assignment. The profile

results will be used to determine if the profiling is more than a year old. In this instance, FHWA will be consulted about the possibility of obtaining new profile data. The speed ranges will determine the target speeds for the test trucks.

RSC Coordination

The Task Leader is responsible for the successful completion of this activity. RSC coordination is a sub-task on the master schedule. It will include requesting information on equipment status (working or not, new or not), what on-site activities resulting in lane closures that may already be scheduled for LTPP would affect truck distributions by lane, and agency activities involving pavement maintenance, rehabilitation or others that could affect traffic patterns within the area of the WIM equipment. The RSC will be notified when a site visit is confirmed so they are aware of potential future scheduling conflicts.

Except for new installations, the RSC will be asked to provide an update of the traffic data from the traffic database for 30 days prior to the receipt of the task order. In addition, if the RSC is responsible for directly downloading data from the site, a copy of the information in a format that includes speed information will be requested. This may be ASCII files that require further manipulation or reports already programmed into the equipment that may be scanned for inclusion in the site evaluation report. When such data is available, a minimum 7-day interval will be requested. This data will be used for comparison against the material reviewed for the site assessment. The data should be available at least 14 days prior to the site visit.

RSC coordination will be documented and the completion of all coordination activities noted on the master schedule. A sample form is shown in Figure 12. The completion is defined as the receipt of all requested information.

RSC Contact/Coordination - SPS WIM

Region: _____ Contact: _____

Phone: _____ e-mail: _____

Team Leader: _____

Site: _____ Visit Date: _____

Task Order: _____ Region notified: _____

Due: _____

	Requested	Due	Received	Notes
Agency Contact:				
Sheet 17 data:				
Site Photo:				
Profile:				
Traffic:				
RSC on-site:				

Comments:

Figure 12 Proposed RSC Contact Record

Agency coordination

The Task Leader is responsible for the successful completion of this activity. Agency coordination is a sub-task on the master schedule. While the key piece of information is the available dates for site visits, other items will be needed. One of the first things to be done is a review, and update if needed, of the contact information for the agency using a Sheet 18 or similar form. Subsequently, with confirmation of the agency's contact for the site and access to the equipment, the information on the Sheet 17 will be reviewed and updated as needed and dates for the evaluation established. The dates selected will reflect any requirements for agency staff participation, holidays or special events or activities that might significantly influence the fleet mix, possible weather conditions and the 120-day deadline from the initiation of the request. The agency will also be asked to provide any traffic control or signing normally required for roadside activities. This may also affect the scheduling.

Agency coordination includes requesting information on equipment status, including any recent equipment installation, maintenance or calibration activities.

Except for new installations, if the RSC is not in a position to provide information with respect to speed and weight for the site, a copy of that information in a format that includes speed information will be requested from the appropriate agency contact. The data may be in ASCII files that require further manipulation or reports already programmed into the equipment that may be scanned for inclusion in the site evaluation report. When such data is available, a minimum 7-day interval will be requested. This data will be used for comparison against the material reviewed for site assessment or previous evaluations. The data should be available at least 14 days prior to the site visit.

A query will also be made as to on-site activities resulting in lane closures may already be scheduled for pavement maintenance, rehabilitation or others that could affect traffic patterns around the WIM equipment.

Agency coordination is not limited to the highway agency but may include others that need to be contacted to obtain the necessary permits for vehicles and work in the right-of-way. Agency assistance may be requested in identifying or locating loads for trucks at sites where Class 9s are not the predominant vehicle type.

Agency contacts will be documented in a consistent fashion. A sample contact record is shown in Figure 13. The completion of all initial liaison activities, as defined by the confirmation of a site visit date, will be noted on the master schedule.

SPS WIM Agency Contact Record:

Site: _____ Visit Scheduled for: _____
Task Order: _____ Due: _____ Visit Type: _____

	Who	phone	e-mail
Agency staff:			
Agency field personnel:			
Access to box:			
Emergency contact:			

	Date	PM/Task Leader	Agency Contact
Equipment condition:			
Within 10 days of TO			
30 days prior			
1 week prior			
1 working day before mob			

Classification Scheme: _____

Class Algorithm requested: _____ Due: _____ Received: _____
Speed Data requested: _____ Due: _____ Received: _____
Sheet 17 review requested: _____ Due: _____ Received: _____

Safety equipment required:
Traffic control requirements:
Time of day restrictions:
Permitting:

Other agencies to be notified:

Figure 13 Proposed Agency Contact Record

Truck Acquisition

All sites will be evaluated with a minimum of two trucks. The first, truck #1, will be a Class 9 (5-axle tractor-trailer combination) with standard tandems and air suspensions on the tractor and trailer tandems. The vehicle will be loaded between 76,000 and 80,000 pounds. The loads will be legal in terms of GVW and axle weights. The second truck will be by preference the predominant truck (including dump trucks) for the particular SPS site if it supplies a substantial percentage of the axle loads for the site. If the predominant truck is a Class 9 then the second truck will be a Class 9 truck similar to truck #1 but loaded between 60,000 and 64,000 pounds. If the predominant truck is not a Class 9, the second vehicle will be loaded within 4,000 pounds of the maximum legal weight for the truck and location.

At sites where the assumption on the predominant truck has been disproved through the assessment process, acquisition of the necessary vehicle and its load will be pursued. If a suitable vehicle cannot be obtained and loaded to match the predominant type, the second vehicle will be a Class 9 similar to truck #1 but loaded between 60,000 and 64,000 pounds.

At sites where the assessment process has demonstrated that more than two trucks are necessary for operational efficiency, this part of the process will obtain the necessary trucks. Due to the non-linear characteristics of some WIM systems with weight, if a third truck is needed the preferred vehicle will be an empty Class 9. On long haul routes where loaded vehicles are the norm a Class 9 loaded between 76,000 and 80,000 pounds with a steel suspension will be the vehicle of choice.

Familiarity with the LTPP traffic data suggests that the Class 9 is the predominant truck at most LTPP sites. It is expected that trailers meeting the requirements will be on long-term lease from a vendor and loaded when the first order including Task 2 assignments is issued. These trailers will be moved from site to site as needed. The intent is to have dry vans loaded with concrete products. Loads will be located to minimize flexure of the truck bed. Appropriate tractors in terms of suspensions and accommodations will be rented on a short-term basis. The drivers for this project may be required to haul trailers between sites or the trailers may be moved as freight.

Handout Guide Revision

The handout guide is a quick reference to the schedule of activities and site information. The material contained will be an update of the post-assessment or previous site evaluation guide whichever is more recent. It includes a schedule of events, points of contact, maps and web addresses relevant to the site and equipment information. The schedule of events will include site activities including any meetings, the start time and the minimum expected time at the site as well as rain date information. Points of contact will include agency and assessment personnel, the relevant FHWA personnel, and individuals or organizations to contact in the event of an emergency. This information will supplement a Sheet 18. Maps will be included for the WIM site location, the airport(s) that can be used, meeting locations and scale locations. In addition, maps of previously driven truck routes and route restrictions will be incorporated. Maps will be supplemented with driving instructions, times and landmark descriptions or photos. The LTPP web page address for SPS Traffic Pooled Fund Study will be included in the handout guide to provide information on the project and associated procedures. The project's web page address will also be included so that interested individuals may check for updates to the schedule and handout guide. The current Sheet 17 will contain location and pavement information as well as the information that has been accumulated on equipment to that point.

Coordination with Phase II Contractor

Under this contract, the necessary trucks and drivers will be available for the Phase II contractor at a newly installed system to calibrate their equipment. The principal coordination task will be agreement on a date for the site visit that leads to the final performance evaluation for the site.

This is a sub-task on the master schedule where it applies. Phase II contractor coordination will be documented and the completion of the coordination activity, defined as confirmation of a site visit date, will be noted on the master schedule.

It is expected that once the Phase II Contractor has completed the calibration process whether by having the site meet the precision and accuracy requirements or having completed the maximum number of calibration attempts, the WIM evaluation will be done. The WIM evaluation consists of the same post-calibration process used for existing sites.

Coordination with the Phase II contractor will be documented in a standard fashion. A sample form appears in Figure 14. Completion of coordination will be documented on the master schedule.

SPS WIM Phase II Contractor Record:

Site: _____ Visit Scheduled for: _____
Task Order: _____ Due: _____ Visit Type: Calibration

	Who	phone	e-mail
Contractor staff #1			
Contractor staff #2			
Emergency contact:			

	Date	PM/Task Leader	Contractor Contact
Equipment condition:			
Within 10 days of TO			
30 days prior			
1 week prior			
1 working day before mob			

Classification Scheme: _____

Class Algorithm requested: _____ Due: _____ Received: _____
Speed Data requested: _____ Due: _____ Received: _____
Sheet 17 review requested: _____ Due: _____ Received: _____

Figure 14 Proposed Phase II Contractor Contact Record

On-site activities

On-site activities reflect a variety of elements conducted in multiple locations including obtaining truck reference measurements, checking the equipment out, gathering the data to evaluate its quality, performing any necessary calibrations, and doing analyses.

The on-site staff will have, in addition to the handout guide, a laptop computer with the cabling and software required to access the equipment, CB-radios, a radar gun, an infra-red temperature gauge, a multi-meter, a digital camera, a video data camera, documentation on the classification scheme, data collection forms, and all software necessary for analysis.

Coordination

Prior to going out to the site, a briefing will be held for all evaluation personnel and other interested parties. This will include a review of on-site activities, refreshers on the weighing process, and double checks of communications equipment. At the conclusion of

the briefing, the field crew will begin truck measurements and site set-up. At a newly installed site, the equipment provider will share responsibility for conducting the briefing.

Site Set-up

Site set-up activities include equipment diagnostics, verification of speeds, and preparations for validation of the classification algorithm. While much of the work will have been done during the assessment or a previous evaluation, a determination that conditions have not changed is necessary for the success of the process.

The initial on-site activity will be equipment diagnostics to verify that the proper signal is being received and all connections are in place. Once the equipment is determined to be functioning, the speed estimates will be checked. The speed validation process will not be limited to trucks.

All of the initial work is done without making any equipment modifications that would affect the loading or vehicle classification output by the equipment.

A video system synchronized with the WIM equipment will be set up to provide a record of vehicles for validation of the classification algorithm. Since WIM systems output vehicle records, a direct link to the system while desirable is not required. Vehicle record and camera time stamps can be used for the comparison process.

Site set-up activities will be the responsibility of the equipment installer at newly installed WIM systems.

Truck measurements

Each truck used in the evaluation will be measured before and after the evaluation. All truck weights will be obtained at certified scales.

A LTPP Traffic Sheet 19, LTPP Traffic Data – Calibration Test Truck # X, (Sheet 19) or a similar form will be completed for each vehicle in the evaluation fleet. If the evaluation extends over more than two days, weight measurements will also be made in the middle of the evaluation period. The measurements will be made even when the same trucks are used for multiple sites. The weight process described in the Data Collection Guide for SPS WIM Sites will be used to obtain two measurements (either direct or computed) of each axle, and three measurements of GVW. In this process, the truck is advanced over the scale one axle group at a time. As each group is added or removed from the scale, a different group total weight is determined. This process provides two estimates of each individual axle group weight either through direct measurement or computations. These measurements are entered in Part II of Sheet 19 (Figure 15).

The field crew will enter the average of these values into their analysis software after the computations on Sheet 19, Part I (Figure 16) or its equivalent has been completed. If the equipment uses different units from the scale, the conversion of the reference data will be made at this point in the process. To verify that the initial weighing process is valid, the

standard deviation of the GVW will be computed. If this value exceeds a third of the allowable tolerance for the 95 percent confidence limit of error for GVW, the weighing process will be repeated.

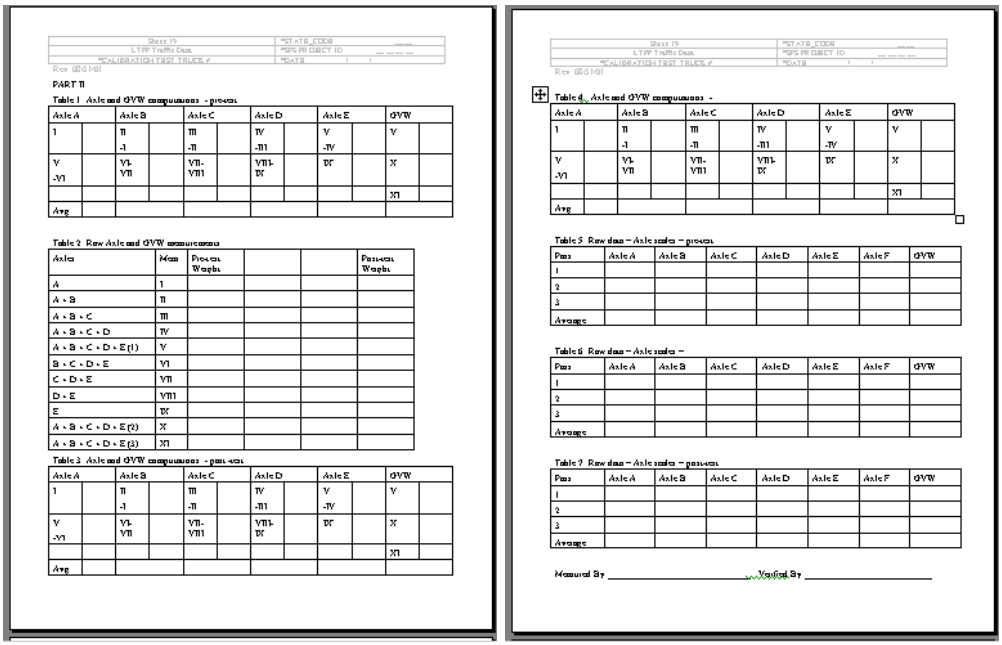


Figure 15 Sheet 19, Part II, for Recording Static Scale Weights

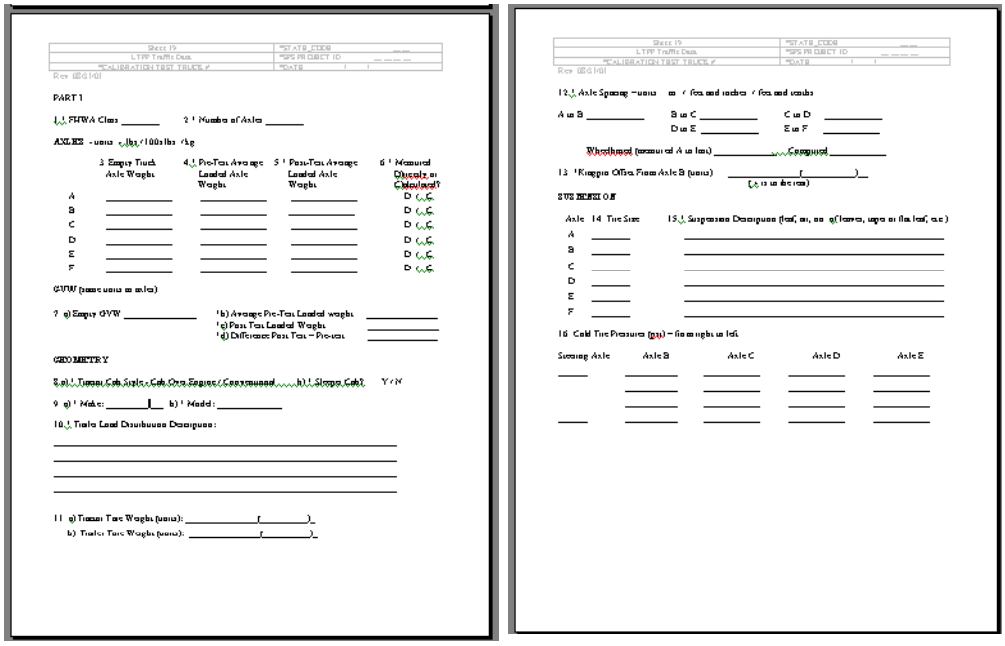


Figure 16 Traffic Sheet 19, Part I - Summary statistics

At the completion of the evaluation the test trucks will be weighed again using the same process and Sheet 19, Part II. If the post-evaluation GVW is within 1000 pounds of the

pre-evaluation GVW, only one measurement of GVW will be done and the remaining two omitted.

Determining Existing Conditions - Evaluations

The initial set of truck runs at a site will be used to determine the quality of the data prior to the evaluation/calibration process. This process described in this section applies to existing systems.

As trucks are run across the scale the following information will be collected: axle weights of the test truck, spacing between each axle on the test truck, speed of the test truck, pavement temperature at the time of the test run, and the calibration factor used by the WIM scale. These attributes can be obtained by simply reading the values off the WIM scale display screen. The data will also be stored permanently. It can be retrieved later for doing the data entry at the end of the initial runs instead of capturing data in real time from the screen. The data will be downloaded at the end of the evaluation for confirmation that data entry at the site was correct. The temperature even if it is an output of the WIM system will be measured independently at a consistent location on the pavement.

If there are problems with the speed data being collected by the equipment, the speed of each truck as it passes over the equipment will be obtained with a radar gun.

At least 40 truck runs with a minimum of 2 runs per truck at each of 3 speeds and 3 temperatures (2 x 2 x 3 x 3 plus spares for missed speeds) will be made prior to making any equipment adjustments. A total of 40 runs is the minimum required to have an acceptable data set for analysis. If turnaround times are such that two trucks between them cannot complete 40 runs in a 10-hour site visit (breaks included), additional trucks will be used. (This will have been determined as a part of the assessment.) If additional trucks are used, the 20 runs per truck minimum will be reconsidered and a sampling plan established to collect an unbiased sample of loads. The requirement for three temperatures may not be achievable at some sites. The principal objective is to complete an evaluation in a day recognizing hours of service constraints on drivers and limitations on traffic control. Forcing the one-day requirement limits the duration per site to a week including travel, a day for each evaluation and a day for calibration in between if required.

The test trucks will move at a constant speed across the scales. The target speeds will have been set based on the 10^{th} and 90^{th} percentile speeds for trucks at the site during daylight hours. A minimum of ten miles per hour should separate the target speeds. However, trucks will not be operated at speeds above the posted limits and should not cause safety problems by operating too slowly.

The method to obtain a range of temperatures is by selecting appropriate times of the day to collect the data. It is important to consider collecting data after the temperature has started to decline to determine whether cooling of the upper pavement layers (while the lower layers stay warm) affects WIM sensor output when scheduling runs. To obtain a

reasonable range of pavement temperature variation it may be necessary to be on site for more than 10 hours per day. Due to the local weather, it may not be possible to obtain a wide enough range to justify stratification into three bins for temperature. In that case, the 40 runs for the day will be split into two ranges. While the target range from low temperature to high temperature is 30 degrees Fahrenheit, failure to obtain it will not result in scrapping the day's effort.

Data will be recorded using LTPP Traffic Data Sheet 21, WIM System Test Truck Records (Sheet 21), or an equivalent format. When all the necessary data has been acquired, an analysis will be done to determine the 95 percent confidence limits of error to compare to the threshold values (Figure 17). Plots will be created of the speed vs. temperature distribution (Figure 18), and the by-run GVW errors versus temperature and speed (Figure 19 and Figure 20).

Characteristic	Tolerance	Site Values All runs	Pass/Fail
Axle Weights			
Steering	" 20 %	-2.5% "6.5%	PASS
Tandem	" 15 %	0.70% " 9.4%	PASS
Gross Vehicle Weights	" 10 %	0.31% " 7.1%	PASS
Axle Spacing			
Between Groups	" 0.5 ft	0.14 ft " 0.9 ft	FAIL
Within Groups	" 0.5 ft	0.02 ft " 0.3 ft	PASS

Figure 17 Sample Analysis Results - All Runs

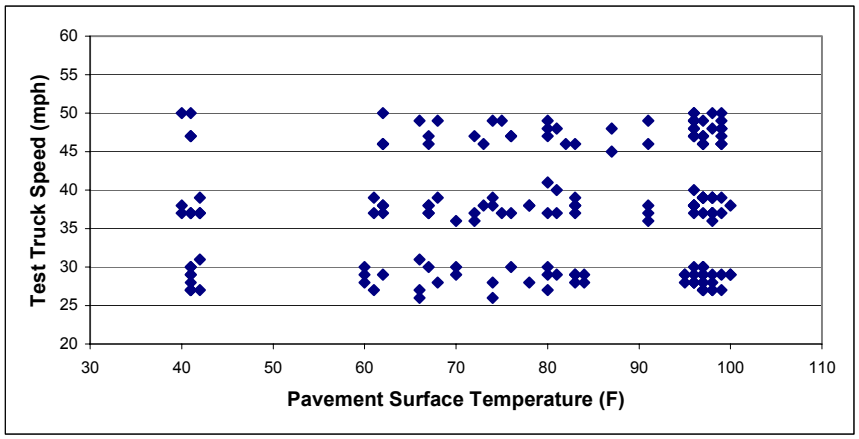


Figure 18 Sample Speed-Temperature Distribution Graph

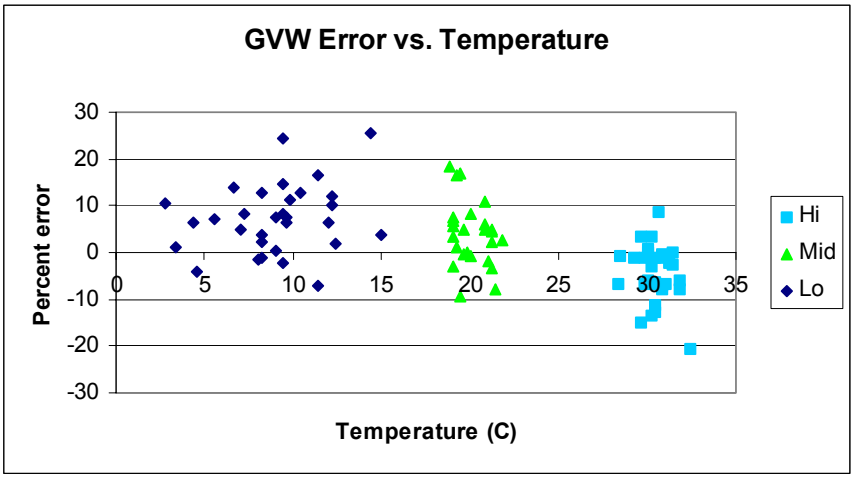


Figure 19 Sample GVW Percent Error vs. Temperature graph

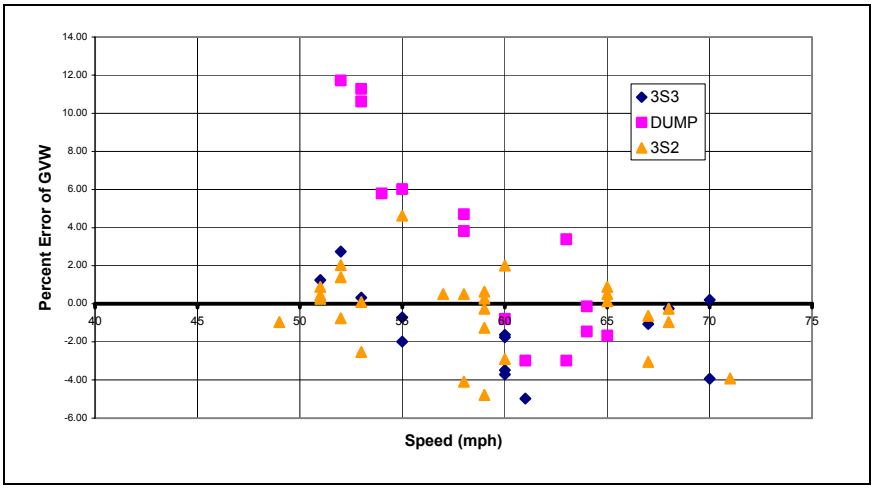


Figure 20 Sample GVW Percent Error vs. Speed graph

If speed or temperature trends are observed, statistics for the appropriate subsets will be calculated and graphed. If speed trends are observed plots of errors by truck will be done. Each bin group will be color-coded on the graph so that any variations by bin are more easily observed. All graphs will be limited to GVW errors unless the manufacturer's calibration procedure requires other inputs. This information will serve as input to the calibration process at sites that fail to qualify as research quality. For sites that are within acceptable limits, this information will support the evaluation report conclusions.

The results of the existing conditions analysis will be summarized on a Sheet 16 for inclusion in the evaluation report and submission to the appropriate RSC.

Determining Existing Conditions - Calibrations

The initial set of truck runs at a newly installed site will be determined by the vendor's calibration requirements. Coordination will be done with the equipment installer prior to commencing the site visit to budget the initial evaluation runs available between pre-

calibration runs and calibration trials. However, the number of initial runs to provide input to calibration will not exceed the 40 required for an initial performance evaluation of an existing site or a day's effort, which ever occurs first. The amount of time budgeted for pre-calibration runs and available for additional calibration runs is limited by the hours of service constraints on drivers and limitations of any required traffic control.

As trucks are run across the scale the following information will be collected by the observer: axle weights of the test truck spacing between each axle on the test truck, speed of the test truck, pavement temperature at the time of the test run, and the calibration factor used by the WIM scale. These attributes can be obtained by simply reading the values off the WIM scale display screen. The data can also be stored permanently. It can be retrieved later for doing the data entry at the end of the initial runs instead of capturing data in real time from the screen. The data will be downloaded at the end of the evaluation for confirmation that data entry at the site was correct. The temperature even if it is an output of the WIM system will be measured independently at a consistent location on the pavement.

If there are problems with the speed data being collected by the equipment, the speed of each truck as it passes over the equipment will be obtained with a radar gun.

The manufacturer's recommended number of runs will be collected for initial performance evaluation. The number of trucks available will be based on turnaround times with respect to the 40-run evaluation requirement. The speed and temperature variations will be consistent with the manufacturer's recommendations. The objective is to complete all pre-calibration runs in a day recognizing hours of service constraints on drivers and limitations on traffic control. Forcing the one day requirement limits the duration per site to a week including travel, a day for each evaluation and a day for calibration in between if required.

The test trucks will move at a constant speed across the scales. The target speeds will have been set based on the calibration process requirements. However, trucks will not be operated at speeds above the posted limits and should not cause safety problems by operating too slowly.

Runs will be made at a range of temperatures identified by the equipment installer and obtainable during the day on site. The run schedule will reflect local weather conditions and the range of temperatures desired.

Data will be recorded using Sheet 21 or an equivalent format. No analysis will be done by the observer for input into the calibration activity. This information will be available to review any reporting and computational deliverables required of the Phase II contractor.

Calibration Requirements for Existing Sites

Using the information obtained in the initial evaluation, the site will be calibrated according to the manufacturer's recommendations.

Adjustments to WIM equipment may be necessary to facilitate the calibration procedure. Various weight errors can be attributed to factors outside of the values installed in the system's software and adjustments must be made to remove as much system and environmental bias as possible.

Temperature bias can be limited by verifying that the temperature sensor is operating properly and that the compensation factors for temperature variations are properly installed in the system's software operating parameters.

Most WIM systems' weight compensation is not linear throughout the range of vehicle weights, especially with respect to lighter vehicles such as passenger cars and lighter delivery trucks. If available, the compensation factor for these vehicles will have to be adjusted in the system's software to ensure that these vehicles are not misclassified. Some systems are also non-linear with speed.

Hardware malfunctions may also interfere with the calibration process. Loop frequency and sensitivity settings must be verified. These will be part of the initial on-site activities. These adjustments can be made using adjustable pots and digital switches on the loop detector circuit board assembly. Proper loop settings will ensure that vehicles are not missed or improperly classified and recorded.

For WIM systems using piezo and bending plate technology, the signal threshold level in the operating software must be adjusted to ensure that the input signals from the sensors are properly buffered to allow for optimum system integration. If the threshold is set too high, axles will be missed, resulting in the misclassification of vehicles. If it is too low, the system will not be able to properly analyze the signal for timing and weight information, resulting in a wide range of spacing, speed and weight errors. Low thresholds can also result in extra or "ghost" axles, causing misclassifications.

After the calibration adjustments are performed a minimum of ten test truck passes will be made. These will be made at varying speeds and at different temperatures to the extent possible. If the system is not yet properly adjusted, the system will be recalibrated. The ten truck passes for calibration and the equipment adjustments will be made until the system meets the precision and accuracy requirements or three sets of truck runs and adjustments are made, whichever comes first.

The same data will be collected post-calibration as for the initial evaluation. Using the post-calibration data the same analyses will be done as for the evaluation. In these circumstances however, it may not be possible to get the same number of groups based on temperature and speeds. The data will be collected on separate Sheet 21s to differentiate between data groups. Separate Sheet 21s will be used following each calibration adjustment.

Calibration Requirements for New Sites

Newly installed sites require a somewhat different division of responsibilities than existing sites. The field staff on this contract will be responsible for making the truck measurements, and providing the truck measurements to the equipment installer, obtaining copies of test run data and documenting the calibration adjustments made. Phase II contractor's staff will be responsible for providing the data, doing any associated analysis to perform the calibrations, making the necessary equipment adjustments and providing the calibration factors for reference. Field staff from this contract will be the liaison between the truck drivers and Phase II contractor's staff. During the calibration process, field staff on this contract will observe the calibration activities and document in detail the steps taken by the equipment provider to calibrate the WIM and VC system. Once the limit on the number of calibration attempts is reached, field staff on this contract will assume responsibility for accessing and collecting the data for the final performance evaluation.

Determine Final Conditions

The final performance evaluation at the site mirrors that of the initial evaluation. A new Sheet 21 is completed, the same analysis is performed and a second Sheet 16 is filled out with the analysis results. The second Sheet 16 is included with the evaluation report and provided separately to the appropriate RSC.

If at the end of the evaluation process the site does not meet the precision and accuracy requirements, the COTR will be notified prior to departure from the site. At this point at least 110 runs will have been completed including the initial 40, 10 in each of 3 calibration attempts and 40 post-calibration. Additional test truck runs that may be required to identify the source of the problem will be limited to the time remaining on-site. Verification of temperature issues may not be possible due to lack of control over weather. It is highly unlikely that additional runs would provide any useful information as the impact of particular suspension types or unusual truck configurations is not within the scope of work.

Classification Verification

It is expected that most of the sites evaluated will have instrumentation that permits real time capture of classification data (vehicle by vehicle classification). As a result, a *Video/Data Synchronization (VDS) System* will be attached to the system to record a picture of the actual vehicle with a date and time stamp and a sequence number. The data recording will cover an eight-hour period.

A serial cable from the equipment and the output of a high-resolution camera will be connected to a video mixer. The real time data from the equipment will be superimposed simultaneously with the video on a monitor and will also be fed into a high-resolution stop action real time recorder.

The camera will be carefully aimed into the traffic stream. The video can then be played back frame by frame and compared to the recorded data files as retrieved from the

equipment. The high quality of the videotape allows vehicle-by-vehicle analysis and comparison to determine the classification accuracies of the equipment.

If the WIM equipment cannot handle both output to a video system and capture of individual truck records for recording and analysis, the video will be taken independently of the WIM equipment. The video clock will be synchronized with the WIM equipment clock.

Based on preliminary the sample size computations, obtaining an estimate of the percentage of errors with a 95% confidence limit will require a sample size between 6 and 90 units. Units may be computed in terms of numbers of vehicles or increments of time. Numbers of vehicles induces error into the computation process in high volume situations when a determination must be made as to which is the first and last vehicle in a sample unit. Arriving at consistent values based on prior experience requires every sample be counted twice and approximately a third counted three times. Selecting time increments such as 5, 10 or 15 minutes simplifies the process of defining the sample unit. Time increments can be defined easily in the field as well and the manual counting process interrupted if necessary. With an 8-hour maximum, it is possible to get the number of sampling units required simply by setting the time increment. Typically a 10-minute increment will be used and the actual 10-minute periods used randomly selected.

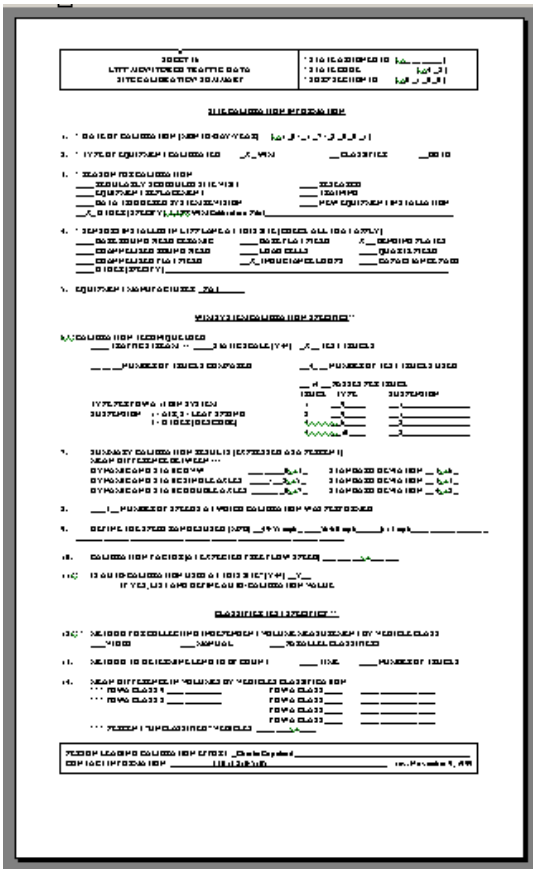


Figure 21 Sample Traffic Sheet 16

The results of the classification will be included on the relevant Sheet 16(s) such as the one shown in Figure 21.

Post-visit activities

The post visit activities include data analyses, update of the handout guide and completion of the evaluation report.

Data Analysis

The data analysis activities include review of the on-site analyses, profile data analysis, determination of the classification findings, and summarization of the data analyses using Sheet 16 for the IMS.

Although it is expected that data entry will be double-checked in the field and the analyses largely conducted by means of project specific software, a review of those elements will be done independently in the office as well.

Profile data analyses will be done in those cases where a request for new profile data was made based on lack of information, pavement rehabilitation or age of data. For sites that had been determined to be marginal and the reason appears to be pavement related, profile data might be requested at this point in the process. This request will be made to improve the knowledge base for decisions on WIM evaluations when the smoothness index cannot make a definitive prediction on success or failure. An amended evaluation report may be submitted as a result.

The video collected in the field for classification validation will be evaluated in the office to determine the estimated error percentages. It is expected that a limited sample will be reviewed in the field, but the primary focus in the field will be on the WIM evaluation and the precision and accuracy of the loading data.

To determine the reliability of the vehicle classification system, the first step is tot obtain the expected population from previously collected data for the same day of the week. Where possible, distributions will be used from the same quarter or month to determine the total expected population of each truck type.

With large numbers of trucks included in the sample size, a normal distribution can be used to approximate the binomial distribution. However, because the desired reliability is so large, the number of trucks in our sample size is also very large, requiring an annual average daily traffic (AADT) of approximately 8,000. Of the SPS projects included in the LTPP program, only 3 in SPS experiments 1, 2, 5, or 6 have a lane AADT that large. Therefore, it will be necessary to use a population sample in all cases. Because it will be necessary to use the population for determining the reliability, the same data will be used for both the determination of percentage of unclassified vehicles and the percentage of truck errors.

The estimated reliability of the system for classifying all vehicles (i.e. not missing any) is the ratio of the number of classified vehicles to the total number of vehicles observed. A confidence interval can be provided for the estimated reliabilities which is provided by:

$$\hat{p} - 1.96\sqrt{\hat{p}\hat{q}/n}\ ,\ \hat{p} + 1.96\sqrt{\hat{p}\hat{q}/n}$$

where:

$\hat{p}$ = the estimated reliability
$\hat{q}$ = 1 – the estimated reliability
n = the number of vehicles included in the sample

The estimates for reliability and the standard error of that reliability are unbiased estimates for the population regardless of sample size. However, practically, it is impossible to count a fraction of a vehicle as misclassified, therefore, the estimates for reliability and the standard error of that reliability will not be provided for vehicle classes that have fewer than 50 vehicles in the 8 hour period. Additionally confidence intervals will not be provided for vehicle classes that have less than 250 vehicles a day as the stated procedure depends on the ability to approximate the binomial distribution with a normal distribution.

In the infrequent event where the WIM equipment does not support real time vehicle review, the statistics will be computed using downloaded data for the day that includes a time stamp for each vehicle. Samples of the data obtained from the 8-hour time frame will be used to calculate the reliabilities.

For quality assurance purposes a sample of 20 percent of the video capture samples will be done by two individuals. For the straight video data collection process, 10 percent of the samples will be done by two individuals.

The traffic analysis conducted in the field will be expanded on for report completion. Data will be reviewed for completeness and transcription errors. Computations by the individual speed and temperature subsets will be completed. Accompanying those computations will be graphs of GVW errors that discriminate between temperature and speed groups. In addition to GVW error graphs, single axle error graphs and spacing error graphs will be created. Site specific conditions will determine what other graphs and analyses may be needed.

Handout Guide Update

There should be few if any revisions to the handout guide as a result of the evaluation except at newly installed WIM locations. In those cases, a new Sheet 17 is expected. Its incorporation into a revised handout guide should be the only necessary post-visit activity associated with it.

Evaluation Report

The evaluation report will include an executive summary, and updated copy of the handout guide and information that supports the evaluation findings and recommendations.

The executive summary, in two pages or less will discuss site field evaluation highlights, findings and recommendations for any problems identified. The revised WIM Site Coordination and Location Handout Guide will be included as an attachment. A second attachment will contain a summary of the analysis activities. The initial information will include data to support the recommendations for sites that fail to meet the precision and accuracy criteria. Also included will be the data collected and equipment adjustments made, previous site results, a forecast of future results, results of new profile evaluations, classification validation results and documentation of equipment diagnostics.

To provide a record of the data quality a Sheet 16 will be completed for the pre-evaluation and post-calibration conditions. The sheet will be dated with the day prior to the evaluation if the entire evaluation and calibration process is completed in a single day. Otherwise the dates on the sheets will reflect the actual initiation of the evaluation activities. A pre-calibration Sheet 16 will not exist for newly installed sites unless more than three months of data have been provided from the equipment to the LTPP Program for use and a standard 40-run initial performance evaluation was conducted. Sheet 16s will be provided to the appropriate RSC.

The proposed evaluation/calibration report outline follows.

Evaluation/Calibration Report – Proposed Outline

Section 1 – Executive Summary

Section 2 – Sheet 16(s)

Section 3 – Corrective Actions Recommended

Section 4 – Handout Guide (per proposed outline)

Section 5 – Post-Calibration Analysis

Overall analysis results including the results table, truck descriptions and graphs including but not limited to speed-temperature distribution graph, GVW errors vs. speed by truck, GVW errors by temperature by truck, spacing errors vs. speed

(continued on next page)

Evaluation/Calibration Report – Proposed Outline (continued)

Subsection A – Temperature-based Analysis using temperature subsets including results table and graphs including but not limited to GVW errors by temperature group, single axle errors by temperature group

Subsection B – Speed-based Analysis using speed subsets including results table and graphs including but not limited to GVW errors by speed group and truck, single axle errors by speed group and truck

Section 6 – Pavement Discussion

Subsection A – Profile analysis with reference to data used in WIM Smoothness Index values

Subsection B – Distress Survey results

Subsection C – Vehicle-pavement interaction discussion

Section 7 – Equipment Discussion

Subsection A – Pre-Evaluation Diagnostics

Subsection B – Calibration Process: factors, computations and relevant graphics

Subsection C – Historical calibration information

Subsection D – Projected Maintenance/Replacement Requirements

Section 8 – Pre-Calibration Analysis

Overall analysis results including the results table, truck descriptions and graphs including but not limited to speed-temperature distribution graph, GVW errors vs. speed by truck, GVW errors by temperature by truck, spacing errors vs. speed

Subsection A – Temperature-based Analysis using temperature subsets including results table and graphs including but not limited to GVW errors by temperature group, single axle errors by temperature group

Subsection B – Speed-based Analysis using speed subsets including results table and graphs including but not limited to GVW errors by speed group and truck, single axle errors by speed group and truck

Section 9 – Data Availability and Quality

Summary of traffic data available in database

Subsection A – Summary of Site Characteristics including as available: expected percentage over-weight and under-weight vehicles, vehicle distribution by hour, speed distributions by hour, GVW axle distributions by class and speed. Characteristics provided for trucks comprising more than 10 percent of the truck population

Subsection B – Expected Values for Data Review including as needed vehicle distribution, Class 9 GVW peaks, speed distributions

Section 10 – Current Sheet 18

CLIN x002B – Process for an Additional WIM

An additional WIM requested at a site is as important to the agency as the primary LTPP equipment. Unless discussions with the agency have indicated a lesser standard or larger allowable variability, the same standards and process will apply to the second WIM.

The evaluation for an additional WIM is predicated on evaluation of the current LTPP WIM. An additional WIM will not be evaluated unless an LTPP WIM evaluation/calibration has been requested for the same SPS project in the same TO.

Relative Location Considerations

If the sites are not in sufficiently close proximity to use the same truck routes they will be evaluated independently. If the sites are on the same truck route, LTPP lane needs will drive truck speed and temperature combinations for initial runs. Any additional runs to complete the speed-temperature matrix for the additional WIM will then be made. While it is possible with two crews to run the sites with different speed targets on the same route it is not prudent. Probable driver and crew confusion as to what elements of the speed-temperature matrix remain to be filled, and short distances over which to make the changes is likely to require additional runs.

If the sites are sufficiently close together that the same truck route is used for both, an expanded field crew may be used for the evaluation. The runs will be made concurrently. If the sites are done on different truck routes, the same field crew will do both sites. The evaluations and calibrations will be done in succession.

Dual Instrumentation Considerations

There are four possible scenarios for an LTPP WIM and an additional WIM being concurrently evaluated. The first is both are existing sites. The second is both are "newly installed". The third is that the LTPP WIM is an existing site and the additional WIM is newly installed. The fourth is that the LTPP WIM is newly installed and the additional WIM is existing. In cases where both require either evaluation or calibration only relative location considerations will impact the runs.

Where one of the sites is an evaluation and the other is a calibration, the determination of whether to do them concurrently or sequentially will depend on relative location. They will be done simultaneously if the same truck route can be used for both. They will be done sequentially otherwise. When done simultaneously, the 40 performance evaluation runs will be done. Breaks in making runs will be defined both by temperature requirements and calibration computation and adjustment interval needs. Speed and temperature sequences will be those required for an initial performance evaluation. The number of calibration adjustment runs will be determined by the site requiring the most runs up to the limit on post-calibration runs. The post-calibration evaluation runs will be done as a group for both sites. When the sites are to be done sequentially due to location, the site requirements will determine the number and types of runs.

Pre-visit activities

The pre-visit activities for an additional WIM are identical to that of the LTPP WIM.

If both sites are intended to support the same SPS project, then there should be no difference in the predominant truck at the two locations.

As with the assessment, a separate handout guide will be prepared for the second WIM.

On-site activities

There is no substantial difference in on-site activities for primary and secondary WIM locations beyond the impact of the existing versus newly installed status of the equipment. Calibration at newly installed sites will be done by the installer. Calibration at existing sites will be the responsibility of this contractor. There are two factors that affect the duration of on-site activity beyond equipment performance, relative location and newly installed versus existing equipment status. All elements of the evaluation and calibration process are those for an LTPP WIM.

Post-visit activities

There is no difference in post-visit activities for primary and secondary WIM locations. A separate evaluation report will be prepared for the additional WIM.

TASK 3 – CONDUCT VC SYSTEM FIELD PERFORMANCE EVALUATIONS

Under this task field evaluations will be conducted of working VC systems to determine if the data is of research quality. If not, actions will be taken on site to calibrate the equipment. This includes the items identified in the RFP Scope of Work as Conduct VC System Field Performance Evaluations. Upgrades of sensors, software or other components are not part of this task although a recommendation on such needs is.

A VC performance evaluation may be requested at any site with stand-alone vehicle classification and no operational WIM equipment. This may be an SPS-8 location, a site at which sufficient research quality WIM data exists but a decision has been made not to repair or replace existing WIM equipment, or a site at which circumstances preclude the installation of WIM equipment. The assessment will be limited to the LTPP lane.

A VC performance evaluation consists of three principal elements: pre-visit coordination and data review, the site evaluation, and a post-visit analysis and reporting process. As a part of the pre-visit coordination process an update of site information is done based on the most recent assessment or evaluation. A variety of methods and sensors are used to collect classification data. Some systems include weight sensors to provide a greater degree of discrimination between vehicle types with the same number of axles and similar lengths. Data is collected that will permit analysis of weight triggers if they are saved, vehicle classifications by hour, speed distributions by hour, GVW distributions if they exist and cross tabulation by vehicle classification of speed, GVW and axle distributions if applicable. The weight-based information will only apply to systems that have weight sensors working and utilized in the classification process. The speed data will identify periods of congestion during which, depending on the

equipment, classification cannot be done successfully. Such periods will be considered in the sampling and evaluation process.

The site evaluation process consists of randomly sampling vehicles by class over at least an eight hour period. However, a visual record is kept of all vehicles in the lane with time, date and sequence number. Based on the sample a determination is made on the need to calibrate the equipment. If the equipment must be calibrated and can be without hardware modification, it will be. The evaluation process will be repeated up to two more times. The performance criteria as stated in the *Data Collection Guide for SPS WIM Sites* are:

- No more than 2 percent of the vehicles recorded being reported as "unclassified", and,
- The number of classification errors involving truck classifications is less than 2 percent.

For the purposes of this study truck classifications are taken to be TMG classes 4 through 13 unless the data reported by system uses an agency scheme. In that case, the statistics will be computed with respect to the agency classifications and definition of trucks.

At the conclusion of the site visit a summary report will be compiled documenting the site activities, data reliability, any corrective actions that may be required and provide information to support the conclusions and other LTPP activities.

A VC system performance evaluation team consists of a Task Leader and one or more technicians. The team is supported by the project's statistician in developing a sampling scheme and by administrative staff to handle logistics and documentation updates.

Deliverables

There are four deliverables associated with this task: master schedule updates, the VC Site Handout Guide, the WIM Site Inventory and a summary report.

A task order for a VC evaluation will result in a site-specific addition to the master schedule on receipt of the request. The schedule update will reflect the typical tasks of pre-visit coordination, analysis preparation, data updates, the site visit and the reporting deadline for the site including whether any additional lanes were requested. Each site-specific portion of the schedule will be modified as site visits are confirmed or rescheduled. Updated master schedule information will be available to the FHWA on a monthly basis or as necessitated by project activities.

The evaluation report is due 15 days after the site visit in three copies (one hard copy to the CO and one hard copy and one electronic copy to the COTR). Included in the report will be:

- An Executive Summary of the evaluation highlighting findings and recommendations,
- An updated VC Site Coordination and Location Handout Guide,
- Updated site inventory information using Sheet 17,
- A copy of the visual records that comprise the sample used to determine whether the data met research quality standards,
- A description of pavement condition,
- A report on the vehicle classification equipment and its condition,
- Documentation of equipment diagnostics,
- Information on historical and current vehicle classification data,
- A Sheet 16 for IMS entry to report on the evaluation results,
- The statistics on data quality with respect to LTPP performance requirements,
- The sampling plan for the site,
- A brief report on the extent of the work done including calibration activities, and,
- Recommended actions if the data is not research quality.

Due to the number of vehicles sampled to obtain a statistically valid determination of the data quality, the copies of the visual records will comprise a synopsis of the vehicles. For any vehicle class a representative picture of a vehicle that was correctly classified will be provided along with the number correctly classified. For any vehicles in the same classification that were not correctly identified, a copy of the failing vehicle and the number of similar failures will be provided. For a given class it is possible that there will be more than one failure including the inability to classify a vehicle or missing it. The complete set of photos or film as applicable will be available on CD-ROM or other computer viewable media. Information on current and historical classification data is expected to be an update of the information compiled at the last assessment or evaluation of the site. The update will include an assessment of any changes in data quality or fleet mix. Since vehicle classification data is expected for the life of the project, there will be no determination of the sufficiency of the data to meet LTPP goals.

CLIN x003A - Process for the LTPP lane

As a result of the evaluation a determination is made as to whether the existing equipment is producing research quality data or not. If not, and the problem cannot be corrected in the course of the site evaluation, recommendations are made on future actions to make it possible to obtain research quality data.

The Task Leader is responsible for the organization of task activities, decisions on issues encountered in the field, preparation of the summary report and all task deliverables. Staff engineers will be used on an as needed basis for data reduction, analysis and reporting of the data as well as the integration of field notes and results into the final report. A field crew will include an individual familiar with the VC equipment, its software, maintenance and capabilities as well as the capabilities of the video capture system. Field crew members are qualified to manually classify vehicles using the same scheme as the installed VC system. The field crew verifies

equipment condition, checks on the pavement condition, installs and operates the video equipment, downloads any supporting data required and samples on site to determine if the data meets the performance criteria.

The following is a prototype of the master schedule entry for this CLIN.

PHASE	ITEM	DURATION OR DEADLINE
PRE-VISIT	**INTERNAL COORDINATION**	From receipt of Task Order (TO) to report submission
	Project Setup	Within 5 working days of receipt of TO
	Work Assignment	Within 10 working days of receipt of TO
	Travel Arrangements	Complete at least 21 days prior to site visit
	RSC Coordination	Within 14 days of receipt of TO through site visit
	Agency Contact Verification	Within 21 days of receipt of TO
	Traffic Data Request	Response due at least 10 days prior to site visit
	Notification of Visit Date	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Confirmation of Equipment Status	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Agency Coordination	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Visit date	Within 30 days of receipt of TO
	Traffic Data Request	Due at least 10 days prior to site visit
	Other (permits, traffic control)	Complete at least 14 days prior to site visit
	Confirmation of Visit	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Confirmation of Equipment Status	30 days prior to visit, 1 week prior to visit & 1 working day prior to visit
	Sampling Design	Complete at least 7 days prior to site visit
	Development based on existing data	3 days
	Design review	1 day
	Handout Guide	
	Review and update	Complete at least 7 days prior to the site visit
	Distribute hand out guide	7 days prior to the site visit
ON-SITE		Complete at least 21 days prior to end of Task deliverable period
	Site Work & Travel	4 days

PHASE	ITEM	DURATION OR DEADLINE
POST-VISIT		Complete within 15 days of end of site visit
	Analysis	
	Traffic Data Analysis	7 days
	Report	15 days
	Report Writing	7 days
	Report Review and Revision	4 days
	Report Submission	No later than15 days after site visit
	Handout Guide	Submitted with report
	Handout Guide update	1 day

Pre-visit activities

There are five basic activities as a part of the pre-visit activities: internal coordination, RSC coordination, agency coordination, sampling scheme development, and handout guide development. Coordination activities will be documented in a consistent fashion. Notification of completion of RSC and agency coordination will be provided electronically via tasks in the master schedule.

The agency contact for the site and the RSC will be contacted for verification of operational equipment status of the equipment and confirmation of the evaluation visit at the following stages:

- Within 10 days of receipt of the Task Order (Project Manager)
- 30 days prior to the site visit(Task Leader)
- 7 days prior to the site visit (Task Leader)
- 1 working day prior to mobilization to the site (Task Leader)

Internal coordination

This is the responsibility of the Task Leader and includes maintenance of site schedule information on the master schedule. The Task Leader will identify staff and travel requirements, locate all previously collected information on the site, and have the sampling scheme created or reviewed. The Task Leader will work with the Project Manager to most efficiently schedule staff and travel.

RSC coordination

This activity will be undertaken by the Task Leader. RSC coordination is a sub-task on the master schedule. It will include requesting information on equipment status (working or not), what on-site activities resulting in lane closures may already be scheduled for LTPP that would affect truck distributions by lane, and agency activities involving pavement maintenance, rehabilitation or others that could affect traffic patterns within the area of the VC equipment. The RSC will be notified when a site visit is confirmed so that they may be aware of potential future scheduling conflicts.

The RSC will be asked to provide an update of the classification data from the traffic database for 30 days prior to the receipt of the task order as will as data from the previous

year for the same period as the evaluation is tentatively scheduled. In addition, if the RSC is responsible for directly downloading data from the site, a copy of the information in a format that includes speed information and vehicle specific data will be requested. This may be ASCII files that require further manipulation or reports already programmed into the equipment that may be scanned for inclusion in the site evaluation report. When such data is available, a minimum 7-day interval will be requested. This data will be used for comparison against the material reviewed for site assessment or previous evaluations. The data should be available at least 10 days prior to the site visit.

RSC coordination will be documented and the completion of all coordination activities noted on the master schedule.

Agency coordination

This activity will be undertaken principally by the Task Leader. Agency coordination is a sub-task on the master schedule. While the key piece of information is the available dates for site visits, other items will be needed. One of the first to be done is a review, and update, if needed, of the contact information for the agency using a LTPP Traffic Sheet 18, WIM Site Coordination, or similar form. Subsequently, with confirmation of the agency's contact for the site and access to the equipment, the information on the LTPP Traffic Sheet 17 will be reviewed and updated as needed and dates for the evaluation established. The dates selected will reflect any requirements for agency staff participation, holidays or special events or activities that might significantly influence the fleet mix, possible weather conditions, and the 90-day deadline from the initiation of the request. The agency will also be asked to provide any traffic control or signing normally required for roadside activities. This may also affect the scheduling.

Agency coordination includes requesting information on equipment status (working or not, new or not) including any recent equipment maintenance or calibration activities and the classification scheme and or algorithms currently in place. The classification scheme is information on what numbers of axles and body combinations define the classes reported by the equipment. The information on the classification scheme will be used to train staff for other than TMG schemes as well as providing a basis for determining whether the equipment has correctly classified the vehicle. The classification algorithm is the information used in the software's equipment to bin vehicles by number of axles, vehicle length, axle spacing and axle weight characteristics. This information will be used to diagnose excessive failures and determine if calibration is possible or an algorithm modification, generally a hardware change will be required to obtain better results.

If the RSC is not in a position to provide information with respect to speed (and weight if applicable) for the site, a copy of that information in a format that includes speed information and vehicle specific data will be requested from the appropriate agency contact. The data may be in ASCII files that require further manipulation or reports already programmed into the equipment that may be scanned for inclusion in the site evaluation report. When such data is available, a minimum 7-day interval will be requested. This data will be used for comparison against the material reviewed for site

assessment or previous evaluations. The data should be available at least 10 days prior to the site visit.

A query will also be made as to on-site activities resulting in lane closures may already be scheduled for pavement maintenance, rehabilitation or others that could affect traffic patterns within the area of the VC equipment.

Agency coordination is not limited to the highway agency but may include others that need to be contacted to obtain the necessary permits for vehicles and work in the roadway.

Agency contacts will be documented and the completion of all initial liaison activities noted on the master schedule.

Sampling for reliability

For each site a sampling scheme will need to be devised based on the available classification information in terms of total volume, fleet mix and time of day distributions. The project's statistician will take the lead in the development of such schemes and review of their application. The data collection done on site must serve two purposes. The first is to determine if the VC equipment on site provides data that meets the performance criteria for research quality. The second is to determine the statistical reliability of each vehicle classification. To determine the overall site performance a sample from the full data collection period will be obtained.

To determine the reliability of the VC system, we will first obtain the expected population from previously collected data for the same day of the week. Where possible, distributions will be used from the same quarter or month to determine the total expected population of each truck type. The following table provides a way of obtaining the reliability of interest.

Class	1	2	…	K	Unknown	Total
# of vehicles being manually classified	m_1	m_2	…	m_K	0	$n = \sum_{k=1}^{K} m_k$
# of vehicles being classified by a VC system	n_1	n_2	…	n_K	$n_{unknown}$	$n = n_{unknown} + \sum_{k=1}^{K} n_k$
# of vehicles being correctly classified by a VC system	n_1^C	n_2^C	…	n_K^C	0	$n^C = \sum_{k=1}^{K} n_k^C$

Class	1	2	…	K	Unknown	Total
Classification Success (reliability)	$\hat{r}_1 = \frac{n_1^C}{m_1}$	$\hat{r}_2 = \frac{n_2^C}{m_2}$	…	$\hat{r}_k = \frac{n_K^C}{m_K}$	0	$\hat{r} = \frac{n^C}{n}$

In this table we denote n the total number of vehicles observed during sampling period of time. Define m_k (k=1,2,…,K) as the number of vehicles in this sample (i.e. n vehicles) being manually classified (assuming manual classification being correct) as the k-th class. Define n_k as the number of vehicles in this sample being classified as the k-th class by a VC system, while $n_{unknown}$ as the number of vehicles whose classes are undetermined. Define n_k^C as the number of vehicles in this sample being correctly classified as the k-th class by VC systems. Clearly, $n_k^C \le m_k$ and $n^C \le n$.

The estimated reliability of the VC system for the k-th class of vehicles is defined as the ratio of the number of correctly classified vehicles of the k-th class to the total number of vehicles observed (i.e. the sample) $\hat{r}_k = \frac{n_k^C}{m_k}$ (k=1,2,…,K). Similarly, the estimated overall (average) reliability of the VC system is the ratio of the total number of correctly classified vehicles to the sample $\hat{r} = \frac{n^C}{n} \le 1$. Both the overall reliability $\hat{r}$ and the reliability by class $\hat{r}_k$ will be computed and reported when evaluating the VC system.

With large numbers of trucks included in the sample size, a normal distribution can be used to approximate the binomial distribution, which best describes the vehicle classification process (i.e., 1 as a vehicle is successfully classified, 0 otherwise). The estimates for reliability and the standard error of that reliability are unbiased estimates for the population regardless of sample size. A 95% confidence interval ($\alpha = 0.05$ significance level) can be provided for the estimated reliabilities, which is provided by:

$$\hat{r} \pm 1.96\sqrt{\hat{r}(1-\hat{r})/n}$$

where:

$\hat{r}$ = the estimated reliability

n = the number of vehicles included in the sample

When sample size is small, the above method for estimating confidence interval using normal approximation is inaccurate. One alternative is to calculate confidence intervals using the binomial distribution itself, though it is complex and computationally demanding. Methods established based on bootstrap resampling simulation techniques or the relationship between the binomial distribution and the F distribution could also be used to obtain confidence intervals of the estimated reliability. These alternatives will be considered whenever applicable and necessary.

However, it is also important to note that when sample size is too small, conclusions drawn from any method become either biased or unhelpful (for instance, the confidence interval is fairly wide in order to achieve a certain level of significance). Practically, to deal with the small sample problem, we may also set up a cutoff sample size. For instance, the estimates for reliability and the standard error of that reliability will not be provided for vehicle classes that have fewer than 50 vehicles in the 8-hour period. Additionally confidence intervals will not be provided for vehicle classes that have less than 250 vehicles a day as this relies on the ability to approximate the binomial distribution with a normal distribution. The cutoff sample size will be eventually determined by statistical justification and on-site measurement on how many vehicles we could observe during observation period.

Because the desired reliability is so large, the number of trucks in our sample size is also very large, requiring an AADT of approximately 8,000. Of the SPS projects included in the LTPP program, only 3 in experiments 1, 2, 5, or 6 have an AADT that large. Therefore, it will be necessary to use a population sample in all cases. Because it will be necessary to use the population for determining the reliability, the same data will be used for both the determination of percentage of unclassified vehicles and the percentage of truck errors.

In the infrequent event where the VC equipment does not support real time vehicle review, the statistics will be computed using binned data. The equipment will be set to produce summaries at 15-minute intervals and the clock on the camera synchronized with the VC equipment. As previously stated, all of the data obtained from the 8-hour time frame will be used to calculate the reliabilities and they will be calculated as previously described.

Data review and assessment

As a part of the coordination process, updates of vehicle classification information will be obtained through either the RSC or the agency. This information will be compared to the data analyses conducted previously as part of a site assessment or evaluation. The updated information and its analysis will be included in the site evaluation report.

The first element will be a review of any weight statistics generated at the site as a part of the classification algorithm. This will typically be done by looking at front axle weights paying attention to those that may be used for auto-calibration and the tails of single axle distributions for irrational percentages. These values will be compared to the previous comparison data set based on the last evaluation. In addition, where the equipment produces GVW, GVW distributions will be generated and compared to the last known validated weight set. It should be noted that trends and changes are only be noted through this process. Weight calibration or adjustment of factors affecting weight data collection cannot be done under a VC system assessment due to a lack of reference values.

The second element will be to review the vehicle class by hour distributions. This information must be generated from the 4-card (or C-card data) provided by the RSC or agency. The distributions will be compared to the previous ones taking into account the

effects of daylight savings to determine the mix that can be expected during daylight hours. Based on the expected distribution by day of week, the existing sampling schemes developed for the site will be considered, or a new one created as needed. The expected and actual distributions by hour will be included in the evaluation report along with the impact of any differences on the sampling scheme's outcomes. An example of such a graph is shown in Figure 22.

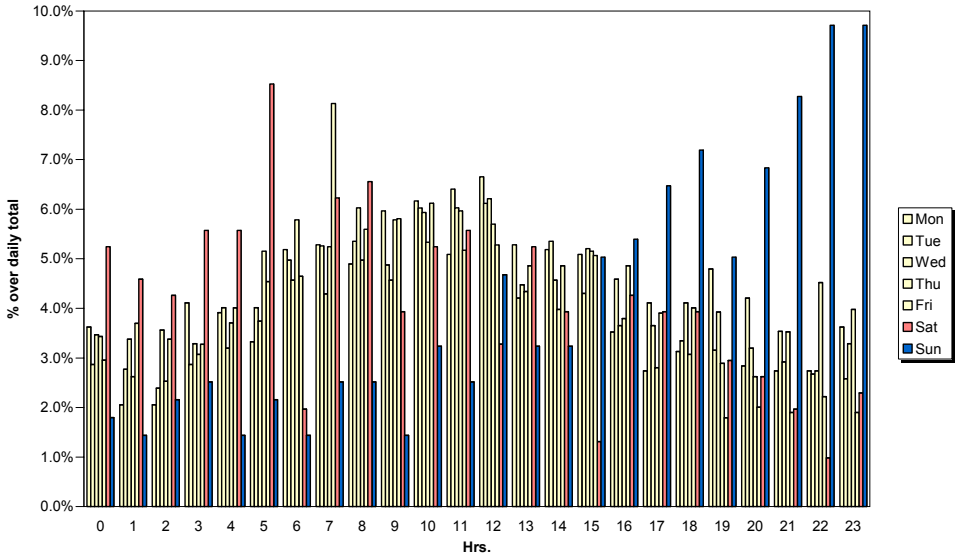


Figure 22 Sample Vehicle Class 9 Distribution by Hour

The third element will be the speed by hour distributions. This will identify any hours during which site evaluation may not be feasible due to congestion or lack of trucks. For safety considerations, both of the field crew and drivers when encountering lighted work zones (light being needed for filming) no data collection is contemplated from local dusk to dawn at any site.

On-site activities

The on-site activities form the basis for determining the quality and reliability of the data. They begin with establishing a safe working environment at the correct location as documented by the current version of Sheet 17. Any changes not previously noted will be documented particularly with respect to the cross-section, pavement surface changes, and new access points to the highway. The team will then evaluate the pavement condition and check out the equipment to include its condition and any diagnostics prior to hooking up the camera. A preliminary classification assessment will be done to see if the site will meet the performance criteria. If the site fails, the Task Leader and PI will be consulted to determine if a full day's evaluation will be done before starting calibration or if the calibration process will be started directly. If the site has a reasonable expectation of meeting the performance criteria data collection will begin. Sampling will be done concurrently with the evaluation period so that a determination may be made at the end of the day as to the calibration requirements for the site. If calibration is not needed the team

will close down the site and complete the preliminary information required for the Sheet 16. If calibration is needed and can be done through the software, a Sheet 16 will be completed, the calibration process will commence. The evaluation process will be repeated when it appears the calibration adjustments are complete. If there is a second calibration evaluation failure, the calibration and evaluation process will be repeated for a final time. A second sheet 16 is then completed. The Task Leader will be notified of complete site failure or when it is determined that the algorithm itself is incorrect for the site.

The field crew in the field will have with it a laptop with the necessary software, cabling, video capture equipment, video and digital cameras, a radar gun, copy of Sheet 17, blank sheet 16s, documentation on the classification scheme, the sampling scheme and software to sample video frames, software for the necessary statistical calculations, and equipment to do manual classification among other items.

Pavement Condition

The field crew will inspect the pavement within two truck lengths on either side of the sensor array making a note of rutting, cracking or faulting that could affect the results. Defects of medium or high severity will be noted and photographs taken as needed to document the conditions. A windshield review of the pavement about a half-mile prior to the site to locate any pavement conditions that might affect the traffic patterns across the sensors in the lane will be done. These are likely to be large potholes yet to be patched or other conditions that would lead drivers to change lanes for a more comfortable ride. The existence of such conditions may also be identified by observing driver behavior in light traffic conditions (less than 1300 vehicles per hour per lane).

Standing to the side of any sensors which require direct contact rather than merely vehicle presence, the staff member will watch vehicles to see if any types are consistently bouncing so as to miss the sensor.

Information on the pavement condition will be entered on a copy of the Sheet 17 for the site under item 5.

Equipment examination

Prior to beginning the survey, there will be a physical inspection of the system and its components. In addition, basic system diagnostics will be run to insure that a signal is being received and that the speed measurements are valid. In the absence of a reference vehicle, axle spacings cannot be checking directly. No adjustments will be made to the system prior to the completion of the initial sampling period.

The results of the pre-evaluation activities will be documented for inclusion in the evaluation report. Any changes in the equipment or sensors will be photographed to use in updating the Sheet 17 information for the site. If there are indications that sensors are no longer firmly or correctly installed in the pavement, these should be photographed as well to support recommendations for maintenance or replacement.

If it has not been possible to get the information required for current speed distribution statistics, an attempt will be made to download the previous week's data in ASCII format to have the information available for analysis.

Video data collection

It is expected that most of the sites evaluated will have instrumentation that permits real time capture of classification data (vehicle by vehicle classification). As a result, a *Video/Data Synchronization (VDS) System* will be attached to the system to record a picture of the actual vehicle with a date and time stamp and a sequence number. The data recording will be run continuously to capture the complete population for subsequent determination of the reliability of the individual classes. The data recording will cover a minimum of eight hours for a "single" session and may be longer depending on sampling requirements.

A serial cable from the VC and the output of a high-resolution camera will be connected to a video mixer. The real time data from the VC will be superimposed simultaneously with the video on a monitor and will also be fed into a high-resolution stop action real time recorder.

The camera will be carefully aimed into the traffic stream. The video can then be played back frame by frame and compared to the recorded data files as retrieved from the VC equipment. The high quality of the videotape allows vehicle-by-vehicle analysis and comparison to determine the classification accuracies of the VC unit.

Preliminary classification assessment

A one hundred percent sample will be taken based on the first hundred trucks or first hour of data, whichever comes first, to see if there is a reasonable expectation of the site meeting the performance requirements. This assessment can only be done if the equipment can report hourly subtotals or be attached to the video capture system. If this is not the case, the minimum data collection period for evaluation will be required before a determination on the need for calibration can be made. If the percentage of unclassified vehicles or the percentage of incorrectly classified trucks exceeds ten percent, a determination will be made as to how much additional data is required to provide information for calibration adjustments rather than collecting data for the minimum required period before beginning. At the end of that period, rather than the minimum 8 hours, the calibration process will begin. Only 3 preliminary classification assessments will be undertaken before a complete classification evaluation is done. A Sheet 16 will be filled out to document the percentage errors by completing the sections on "Site Calibration Information" and "Classifier Test Specifics" after the first assessment if a calibration adjustment is needed. The sheet will be dated with the date prior to the evaluation to indicate that it reflects information up to the evaluation date.

The percentage of unclassified vehicles will be determined by one of the several methods depending on the sampling interval and the equipment capabilities. If the sampling interval is an hour and the equipment can report the hourly totals by class including the

unclassifieds and/or unknowns, the hourly totals will be used with unclassifieds as the numerator and the total volume for the lane as the denominator. If the equipment cannot report an hourly subtotal while continuing to collect data, the video will be reviewed and a count of all vehicles by class will be made using the classes reported by the equipment. The same computation will be done. The expected error rate for manual counting from video with trained staff is 0.5 percent. This is too low to affect the computation of the percentage unclassified for the determination of a reasonable expectation of meeting the performance requirements. If observing 100 trucks counted manually ends the sampling interval, the video will be manually counted to determine using the overlaid classifications the total number of vehicles by class including unclassifieds and or unknowns. The same computation will be made as in the other cases.

Computing the percentage of misclassified trucks must recognize the existence of three possible conditions: trucks are correctly differentiated from passenger vehicles but misclassified between truck types, cars and pickups are included in the truck counts, and trucks are included in the passenger vehicle counts. The issue is further confounded in the instances where the agency scheme is not that of the TMG or the algorithm for assigning vehicles to classes is unknown. The computational processes will vary depending on the outcome of the sampling period counts.

Classification Evaluation

The classification evaluation is used to determine whether the VC equipment is correctly classifying vehicles according to the classification scheme in use at the site. Data will be collected for at least an 8-hour period using either video data capture with overlays of equipment classifications or video cameras with clocks synchronized to the equipment clocks to obtain a visual record of the traffic stream. The data collection period will include the initial classification assessment period if there is no immediate indication that a calibration will be required. A longer period may be recorded if needed to obtain a sufficient number of samples to determine the performance of the equipment with respect to the research criteria. The site specific sampling process will begin as video becomes available for review whether it is video capture or straight video. The computations will be done at the end of the collection period with any additional data required being downloaded from the VC equipment.

The methods used in the preliminary classification assessment will also be used for each of the individual samples to determine the individual percentages of unclassifieds and misclassifieds. The sampling scheme is intended to provide an estimate of the error rate with a 95% confidence limit for comparison against the performance criteria.

If the VC system meets the performance criteria, a Sheet 16 will be completed for the record. If the VC system fails to meet the performance criteria, the data will be reviewed to determine what adjustments should be made to improve the equipment's performance. If the adjustments can be made on site, they will be and the process of preliminary classification assessment and classification evaluation repeated. Only 2 preliminary classification assessments will be done before beginning a repeat of the classification evaluation. The maximum number of classification evaluations done at a site is three. If

the third evaluation fails, a Sheet 16 will be completed to document the conditions at the conclusion of the evaluation process. The Sheet 16 completed at the end of the VC evaluation process will be dated with the date of the completion of the site visit.

Calibration

The calibration process involves making equipment or software adjustments to reduce the number of missed or unclassified vehicles or to adjust the binning of individual vehicle types.

Many different types of data errors encountered with various types of VC equipment may be resolved by making manual changes to system components or system operating parameters while on site.

Inductive loop malfunctions account for a high number of classification errors. These errors are many times the result of identical or very close frequency settings or incorrect sensitivity, response or delay settings. Loop frequencies and sensitivity adjustments can be made by either using adjustable pots or digital switches. These pots or switches are typically located on the loop detector board. Within the system's operating software, the loop's delay time, response time and minimum detection time may also be adjusted. This would be used for fine-tuning the system in cases of high or low volume traffic, or specialized vehicles such as logging trucks.

A common problem with classification equipment using piezo sensor technology is the threshold used by the system to validate sensor signals. If this threshold is set too low, it will create significant error in axle spacings, speed and therefore classification. This setting can be adjusted within the system's operating software while simultaneously observing real time data to ensure valid axle spacings.

The majority of errors not caused by settings for in-road sensors such as loop frequencies or sensitivities or piezo threshold settings are the result of incorrect system operating parameters. System sensor assignment and sensor distance settings, improperly set, can cause significant data error percentages. These settings would all be verified during the calibration process.

Classification errors such as overall vehicle length can be fixed by a combination of adjustments. Systems that give improper true or "magnetic length" can be adjusted by changing the loop length setting in the system's operating software. Increases or decreases in loop sensitivities may also be used to adjust vehicle length data. Systems that use the sum of axle spacings to determine length can only be adjusted by the sensor distance setting in the system's operating parameters.

Post-visit activities

The post-visit activities include verification of the classification findings, completion of a sheet 16 for classification and preparing the evaluation report.

The classification results for the system as a whole will be checked at this point. In addition, the individual reliabilities by vehicle class will be determined for inclusion in the report. For quality assurance purposes a sample of 20 percent of the video capture samples will be reviewed. For the straight video data collection process, 10 percent of the samples will be reviewed.

The evaluation report will include a two page (maximum) executive summary, video images and data to support the findings of the evaluation. As discussed in the deliverables section, the classification successes and failures will be summarized by type and sample unit.

A proposed outline for such a report follows.

VC Evaluation Report – Proposed Outline

Section 1 – Executive Summary

Section 2 – Sheet 16(s)

Section 3 – Corrective Actions Recommended

Section 4 – Handout Guide (per proposed outline including Sheet 17)

Section 5 – Post-Calibration Analysis
Overall analysis results including sampling scheme, counts of correctly and incorrectly classified vehicles by actual class, representative visual records, computations.

Section 6 – Pavement Discussion
Subsection A – Distress Survey results
Subsection B – Vehicle-pavement interaction discussion

Section 7 – Equipment Discussion
Subsection A – Pre-Evaluation Diagnostics
Subsection B – Calibration Process: factors, computations and relevant graphics
Subsection C – Historical calibration information
Subsection D – Projected Maintenance/Replacement Requirements

Section 8 – Pre-Calibration Analysis
Overall analysis results including sampling scheme, counts of correctly and incorrectly classified vehicles by actual class, representative visual records, computations.

Section 9 – Data Availability and Quality
Summary of traffic data available in database
Subsection A – Summary of Site Characteristics including as available: vehicle distribution by hour, speed distributions by hour,
Subsection B – Expected Values for Data Review including as needed vehicle distribution

Section 10 – Current Traffic Sheet 18

Section 11 – Copy of Visual Records

SUPPORTING ACTIVITIES

The following activities are also required for the successful completion of this project: incorporation of the LTPP WIM site smoothness index in software, software for streamlining video reduction, on-site analysis tools, style guides for reports and a work guide including QA processes for the project as a whole.

It is assumed the LTPP WIM site smoothness index will already be incorporated in software. This project will not modify the software provided to handle non-LTPP profile formats.

To reduce the amount of time spent locating and creating the individual video images required for the VC evaluation process, video software with the capability of making slides of individual frames will be acquired. MACTEC currently uses ACDSee for similar work in video distress takeoffs and expects to use it on this project.

To provide uniformity in evaluation analyses, a set of tools will be created to generate the standard statistics and graphs. It is anticipated that this will consist of a set of Excel spreadsheets with VB macros for the standard WIM cases (2, 3 or 4 trucks). These spreadsheets will form the basis of any others needed when it is necessary to depart from the 20 run minimum. These are tools to provide analysis results and are not a deliverable under the contract. Analysis tools for calibration are equipment specific and are already available to the team.

Due to the requirement for consistent reporting formats, document templates for the assessment and evaluation options will be developed.